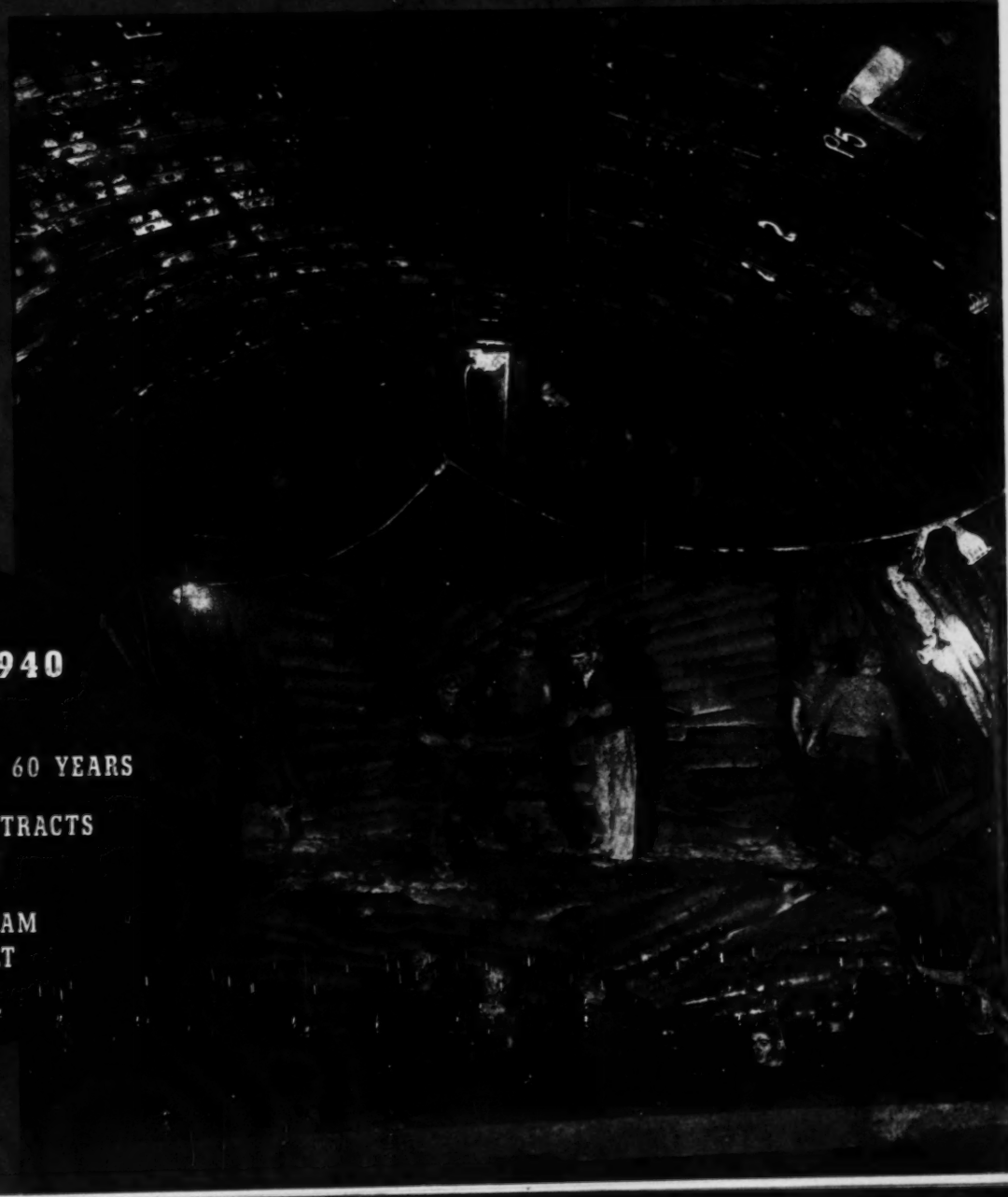
ENGINEERING NEWS-RECORD

AUG 5 1940



AUGUST 1, 1940

★

USES BUILT TO LAST 60 YEARS

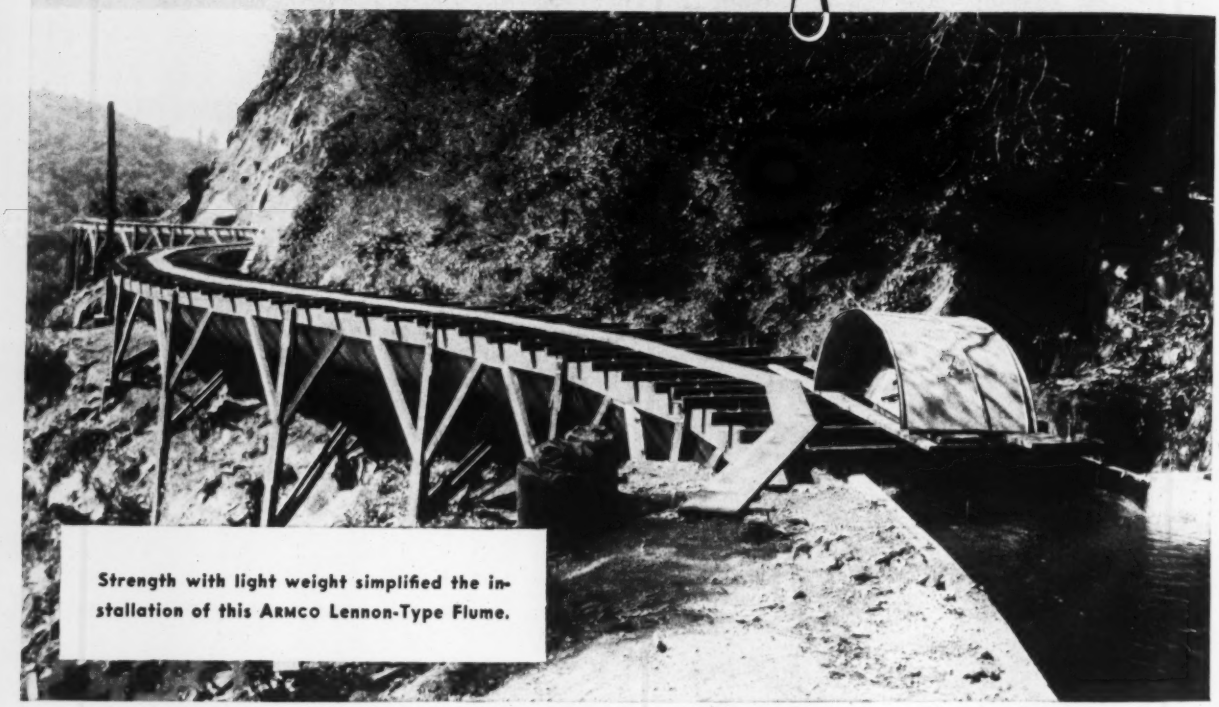
CONSTRUCTION CONTRACTS FOR DEFENSE

HOW FRIANT DAM IS BEING BUILT

Stop Leaks . . .

Save Dollars

WITH THESE STURDY FLUMES



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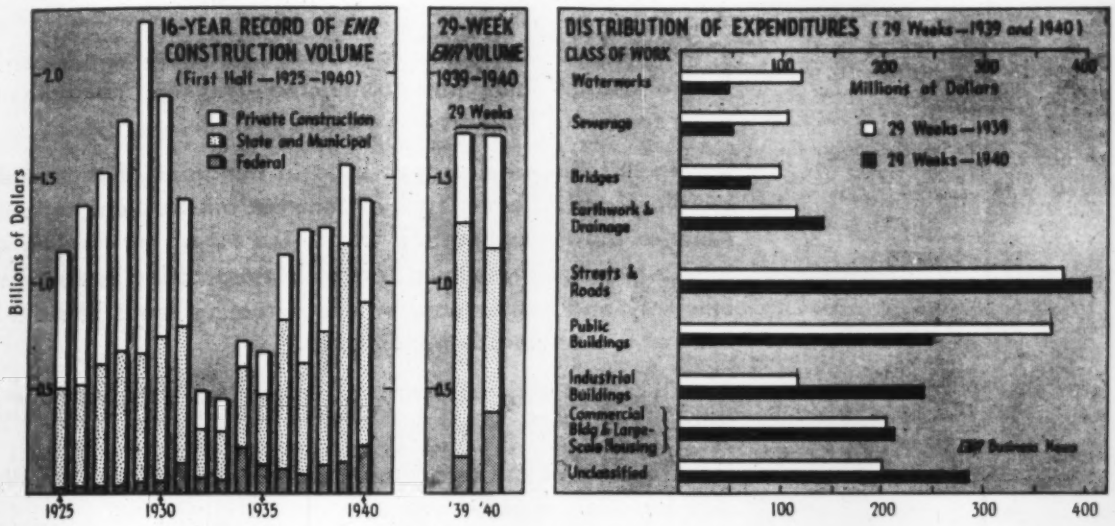
ARMCO

LENNON-TYPE FLUMES

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry



Three-week spurt brings construction to 1939 level

RECORD engineering construction volume in the three weeks since the close of the first half have boosted 1940 volume to within 1 per cent of the level reported for the corresponding 1939 period.

The current volume lagged 11 per cent behind last year's pace at the end of the first six months, but with the impetus of federal defense awards and industrial construction during the past three weeks the 29-week volumes are just about equal.

It is worth noting here that some of the manufacturing plant expansion that would normally be carried out by private companies is now being built by the government under private supervision. A notable example is the smokeless powder plant being erected in Indiana by the War Department and supervised by du Pont.

In spite of the fact that industrial buildings paid for and owned by the government are recorded in construction volume under "public buildings" the *ENR* private industrial construction figure even without this federal "industrial" building is currently riding 104 per cent ahead of a year ago.

To air base construction and improvements in the last three weeks goes the credit for a 42 per cent increase for unclassified construction over the 29 weeks of 1939. At the end of the half it was 14 per cent below last year's total for the opening six-month period.

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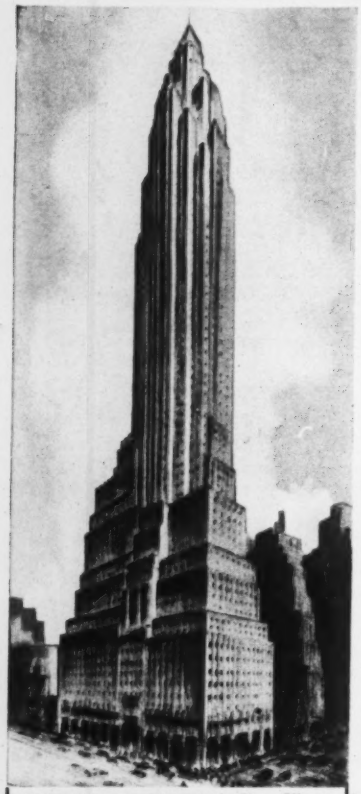

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FOR thirty years Truscon Waterproofing Paste—the pioneer integral waterproofing paste compound—has kept faith with architects, engineers, builders and owners.

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F. E. SCHMITT AND WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 AUGUST 1, 1940 No. 5

THIS WEEK

• How Friant Dam Is Being Built—A study of the construction plant, its design, equipment and operation, all keyed to meet the demand for economical production of aggregate and placement of 2,000,000 cu. yd. of concrete. Fast hammerhead cranes and revolving derricks operating from a high steel trestle are used to advantage in delivering concrete to the forms.

• Expansion Joint Study—A review of the experimental studies being made by the Oregon State Highway Commission to determine: (1) load transference efficiency, (2) watertightness and (3) reasonable freedom of movement, involving five types of expansion joints on concrete paving.

• Hand Mining on Chicago Subways—deals with the first stages of a comprehensive subway system involving the tunneling of 7.7 miles of double-track tubes, 4.6 miles of which is being built by hand-mining methods. The procedure improves on the long-established soft-ground methods employed in Chicago sewer construction by eliminating the usual needle beam through adoption of a better steel rib, plate ground supports and consistent use of compressed air up to 12-lb. pressure.

THINGS TO COME

• Replanning American Cities for Better Living—A plea for a new concept of engineering, economics and property rights, looking toward the development of a workable plan for rebuilding our cities as a means of stabilizing populations. To be published soon.

• The largest cement-lined, centrifugal cast-iron pipe yet made, 48-in. diameter, is being used for a 30-mile water line at Wichita. This is the first pipe of this size to be produced for exact load conditions, external as well as internal. The problems involved in laying this pipe and their solution will appear in the Aug. 15 issue. "Wichita Makes Cast-Iron Water Line History" is the title.

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- Etc., Etc.

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CONTRACTS AND CAPITAL

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(,000 omitted)	July 1939	July 1940	% Change	Seven Months 1939	Seven Months 1940	% Change
Total Construction	$181,469	$352,852	+94.0	$1,744,693	$1,742,468	−0.1
Private Construction	48,722	68,550	+41.0	438,870	552,794	+26.0
Public Construction	132,747	284,302	+114.0	1,305,823	1,189,674	−9.0
Federal	24,285	177,217	+629.0	174,704	392,648	+125.0
Total New Productive Capital	$817,934	$1,067,271	+30.5	$1,769,120	$1,699,806	−4.0
Private Investment	71,148	98,555	+39.0	518,310	636,937	+23.0
Federal (non-federal work)	236,686	185,144	−22.0	429,283	279,297	−35.0
Federal (federal work)	510,100	783,572	+53.0	821,527	783,572	−5.0
FHA Mortgages Selected for Appraisal	$84,482	$118,731*	+41.0	$686,587	$753,464*	+10.0

*Preliminary.

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	August 1939	August 1940	% Change	Change July to August 1939 July	1939 Aug.	1939 %	1940 July	1940 Aug.	1940 %
E N R Construction Cost Index, 1913 = 100	234.90	242.18	+3.1	234.94	234.90	‡	242.15	242.18	‡
E N R Building Cost Index, 1913 = 100	196.54	201.71	+2.6	196.78	196.54	−0.1	201.68	201.71	‡
ENR 20-CITIES' AVERAGE									
Common Labor	$0.685	$0.707	+3.2	$0.684	$0.685	+0.1	$0.707	$0.707	0
Skilled Labor (Av. 3 trades)	1.444	1.476	+2.2	1.444	1.444	0	1.476	1.476	0
Bricklayers	1.538	1.568	+1.9	1.538	1.538	0	1.568	1.568	0
Structural Ironworkers	1.499	1.535	+2.4	1.499	1.499	0	1.535	1.535	0
Carpenters	1.296	1.330	+2.6	1.296	1.296	0	1.330	1.330	0
Cement, per bbl	$2.60	$2.52	−3.1	$2.60	$2.60	0	$2.51	$2.52	+0.4
Reinforcing steel, cwt	2.44	2.49	+2.0	2.45	2.44	−0.4	2.43	2.49	+2.5
Struct. steel, base price	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.21	1.17	−3.3	1.21	1.21	0	1.17	1.17	0
Lumber, 2x4 Fir, M ft	32.30	34.97	+8.3	32.38	32.30	−0.2	34.88	34.97	+0.3
Lumber, 2x4 Pine, M ft	28.50	31.12	+9.2	28.86	28.50	−1.2	31.15	31.12	−0.1
Brick, common, per M	14.23	14.35	+0.8	14.24	14.23	−0.1	14.34	14.35	+0.1
Ready-mixed concrete, c.y.	7.10	6.94	−2.3	7.09	7.10	+0.1	6.94	6.94	0
Str. clay tile, 3x12x12	74.27	74.49	+0.3	74.27	74.27	0	74.49	74.49	0
Paving asphalt, cars, ton	13.88	14.20	+2.3	13.94	13.88	−0.4	14.16	14.20	+0.3

‡Less than .05 per cent change.

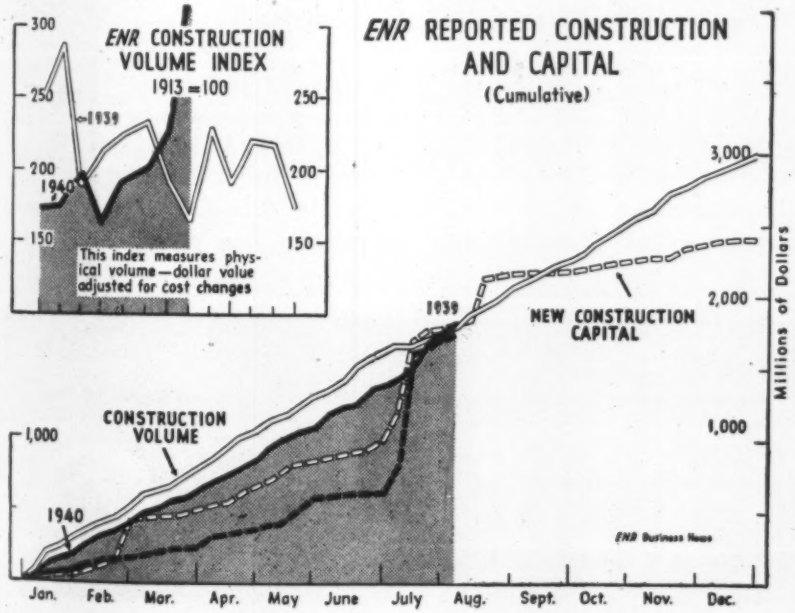
MATERIAL SHIPMENTS . . . BUILDING PERMITS

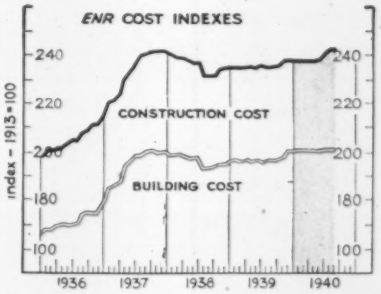
	July 1939	July 1940	% Change	June 1940	% Change June–July
Lumber (% 1929 wk. seas. av.) N.L.M.A.	67.3	71.5	+6.2	73.3	−2.5
Steel (% operating capacity) A.I.S.I.	51.3	83.9	+63.5	84.8	−1.1

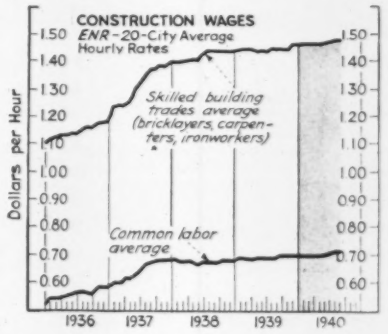
	June 1939	June 1940	% Change	Six Months 1939	Six Months 1940	% Change
Fabricated Struct. Steel, tons, A.I.S.C.	130,114	111,211	−14.6	670,827	643,105	−4.2
Cement, thous. bbl., U.S.B. of M	12,715	13,216	+3.9	54,268	53,795	−0.9
Building Permits, Dun & Bradstreet, (000 omitted)	$120,912	$115,028	−4.9	$621,371	$649,706	+4.6

RENT INDEX . . . EMPLOYMENT

	June 1939	June 1940	% Change	May 1940	% Change May–June
Rent (Housing) Index N. I. C. B.	86.0	86.8	+0.9	86.7	+0.1
Est. Total Employment, N. I. C. B.	45,431,000	46,860,000	+3.2	46,172,000	+1.3
Est. Constr. Employment N. I. C. B.	2,159,000	2,179,000	+0.9	1,969,000	+10.5


ENR CONSTRUCTION VOLUME INDEX
1913 = 100
1939
1940
This index measures physical volume—dollar value adjusted for cost changes
ENR REPORTED CONSTRUCTION AND CAPITAL
(Cumulative)
NEW CONSTRUCTION CAPITAL
CONSTRUCTION VOLUME
Millions of Dollars
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.




CONSTRUCTION WAGES
ENR–20-City Average Hourly Rates
Dollars per Hour
Skilled building trades average (bricklayers, carpenters, ironworkers)
Common labor average
1936 1937 1938 1939 1940

CONTRACTS

(Thousands of dollars)

	Week Ending Aug. 3 1939	July 25 1940	Aug. 1 1940
Federal	$2,304	$15,071	$29,436
State & Municipal	27,866	24,557	45,778
Total public	$30,170	$39,628	$75,214
Total private	17,308	12,752	14,388
TOTALS	$47,478	$52,380	$89,602
Cumulative 1940 (31 weeks)			$1,827,070*
1939 (31 weeks)			$1,792,171

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

*Revised.

NEW PRODUCTIVE CAPITAL

	Cumulative 1939 31 Wks.	1940 31 Wks.
NON-FEDERAL	$970,146	$937,491
Corp. Securities	141,201	112,664
State & Mun.	384,829	533,620
R.E.A. loans	89,445	...
U.S.H.A. loans	160,852	99,058
R.F.C. loans	3,819	8,149
Fed. Aid-Hwy	190,000	184,000
FEDERAL	$821,527	$783,572
TOTAL CAPITAL	$1,791,673	$1,721,063

FHA MORTGAGES

	Week Ending July 29 1939	July 20 1940	July 27 1940
Selected for appraisal	$20,305	$26,505	$27,164*
Cumulative 1940 (30 weeks)			$739,464*
1939 (30 weeks)			$680,866

* Subject to revision.

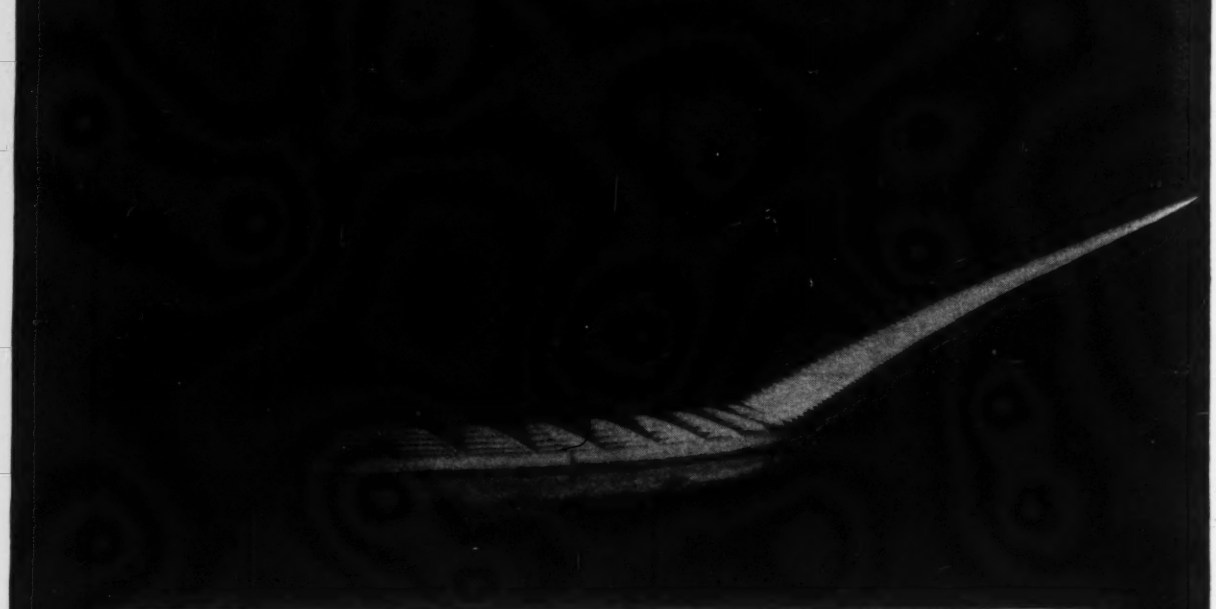
ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	1926	Building Cost '13	'26	Volume '13	'26
Aug., 1940	242.18	116.42	201.71	109.04	...	...
July, 1940	242.15	116.40	201.68	109.02	314	137
June, 1940	241.59	116.13	201.65	109.00	225	99
Aug., 1939	234.90	112.92	196.54	106.24	228	100
July, 1939	234.94	112.94	196.78	106.37	166	73
1939 (Av.)	235.51	113.21	197.44	106.73	211	92
1938 (av.)	235.86	113.34	196.83	106.40	197	86
1937 (av.)	234.71	112.66	196.15	106.07	172	75
1936 (av.)	206.42	99.15	172.18	93.14	185	81

July Construction Table on page 36

CAR HEADLIGHTS ALONE LIGHT THIS

glowing guide to safety at night!



THIS is White Concrete Reflecting Curb on a rainy, black night when visibility is normally zero. Brilliance of the curb is due entirely to headlight rays which are reflected back to the driver's eyes from scientifically designed sawtooth faces.

Now in use on many of New Jersey's heavily traveled highways, this curb, made with Atlas White cement, defines the road by day. And at night, with no other illumination than car headlights, it forms a bright guiding ribbon, extending far in front of the car.

It will pay you to consider White Concrete Reflecting Curb for your highways. Write today for further information on this new type of curb. Address Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Dept. C4, Chrysler Building, New York City.

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MADE WITH ATLAS WHITE CEMENT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • AUGUST 1, 1940

Reclamation Bureau stages program for civil engineers

Meeting of American Society of Civil Engineers at Denver was also the scene of much discussion of defense construction problems

Measures looking toward defense preparedness, a census of engineers, salaries and fees, engineering education and a review of technical division activities were the principal subjects of general interest covered last week in Denver by the Board of Direction of the American Society of Civil Engineers, meeting prior to the 70th annual convention, July 24-26. The technical program of the meeting itself was built around the activities of the U. S. Bureau of Reclamation and western problems. Some 26 papers and reports, following a general symposium on reclamation, were presented to six technical divisions in the two days allotted. A highlight of the meeting was "open house" at the U.S.B.R. laboratories.

Defense planning activities

Defense preparedness so far has taken the form of an elaborate census developed through the Construction Advisory Committee and the National Committee on Construction Preparedness as outlined in *ENR* June 13, 1940, p. 823. Col. John P. Hogan, president ASCE, heads the former committee which was appointed May 6 by the Army and Navy Munitions Board to advise upon legislation, contract forms, fees, salaries and personnel.

As reported by George T. Seabury, secretary, ASCE, 55 of the 61 local sections have submitted 3,139 names of consultants and engineers in private practice available for use in the design and supervision of construction of such facilities as might be needed in a preparedness program. From this list, up to July 15, 1,783 had received questionnaires which have been filed by name, by state and by major specialty with numerous supplementary cross references.

The second census step, now under way, is that of accumulating lists of available engineers, surveyors, draftsmen, engineering assistants and specialists for assimilation into existing firms to which assignment of work might be made. Local sections will cooperate with other local engineering organizations in maintaining the lists locally.

A third step arose from the request of the Quartermaster General for a list of engineers between the ages of 30 and 45 from which captains and majors might be commissioned. Names of 423 engineers sent in from 31 local sections were obtained up to July 15.

At the recommendation of the professional objectives committee the board directed that a staff member be assigned to Washington to look after the interests, including fees and salaries, of all civil engineers who may be engaged on defense construction work.

Principal board actions

The Board of Direction approved the recommendation of its newly established committee on division activities for the establishment of a civilian defense committee in place of an air protection division as petitioned by a group of members. A suggestion recently made for a transportation division was not acceded to but it was agreed that a petition for a railway division would meet with favor. Subjects planned to be handled in a proposed airways division are to be apportioned to existing appropriate divisions. The board also approved reviving the engineering economics division with new personnel, and requested the hydraulics division to cover the field of hydrology through inclusion of suitable papers in its programs.

The salary committee reported that the Arizona Highway Commission had accepted the proposed schedule of classification and salaries worked out by a staff member, with a revision upward of

(*Continued on p. 34*)

Men who made the wheels go round

Engineers who arranged the interesting convention of the American Society of Civil Engineers at Denver, Colo. July 24-26 posed for this picture at the convention hotel. Left to right (front row) they are: Roy A. Klein, president, Colorado Section; John P. Hogan, president of the national organization; Norman W. Funk, general chairman, committee on arrangements (back row) George T. Seabury, secretary of the society; Sidney Wilmot, society manager of publications; D. P. Barnes, new editor of Civil Engineering; *and Allen P. Richmond, Jr., assistant to Secretary Seabury in the New York headquarters.*

Defense construction organization takes shape in Washington

Civilian consulting and coordinating boards and army and navy officials add personnel almost daily

Like NRA code days, but with incomparably more dispatch and strength of purpose, an organization is being molded in Washington to plan and direct the construction industry's part in national defense. Almost daily new appointments are being made from civil engineer ranks to consulting and coordinating boards. In the Office of the Quartermaster General (OQMG), Construction Division, which handles War Department construction, and in the Bureau of Yards and Docks, where the Navy Department's shore station construction heads up, personnel is being stabilized in top key jobs. A pattern for the national defense construction program is beginning to take shape. As of this week the chart shown herewith, drawn by *Engineering News-Record*, depicts the lines of authority and consultation in the construction industry's sphere of interest.

The end objective, of course, is to provide the fighting forces with what they ask for. Who in what bureaus, boards and commission plays a part in translating these requests into contracts for the construction industry is outlined in the following. Only public works, and largely those connected with the strategic plans of the military forces, are considered. Construction incident to expansion of private industrial plants is another story and one which follows more nearly a peacetime procedure.

The top bodies

At the top are the War and Navy departments, whose orders are transmitted directly to their construction arms, the Quartermaster Corps (Gen. C. D. Hartman, chief of construction division) and the Bureau of Yards and Docks (Rear Admiral Ben Moreell, chief). From these organizations, either directly or through other governmental agencies, flow the contracts for actual construction. Peacetime or wartime, such procedure is the same.

What makes present practices special are the special advisory boards and commissions that have been appointed and the existing governmental agencies whose construction activities are being turned to national defense.

Topmost advisory and planning body is the Army and Navy Munitions Board, made up of the assistant secretary of war, the assistant secretary of the navy and an executive committee of army and navy officers. It is the implementing force behind the industrial mobilization plan, which was inaugurated following the World War, to insure that the nation's industrial peacetime capacity (the construction industry included) could be speedily turned to defense production. Of the Board's four control divisions, one is the Facilities Division, in which is the Construction Section headed by Maj. L. J. Dillon. Here, the plans for what the army and navy would need from the construction industry in time of emergency have been collected, analyzed and programmed for many months past.

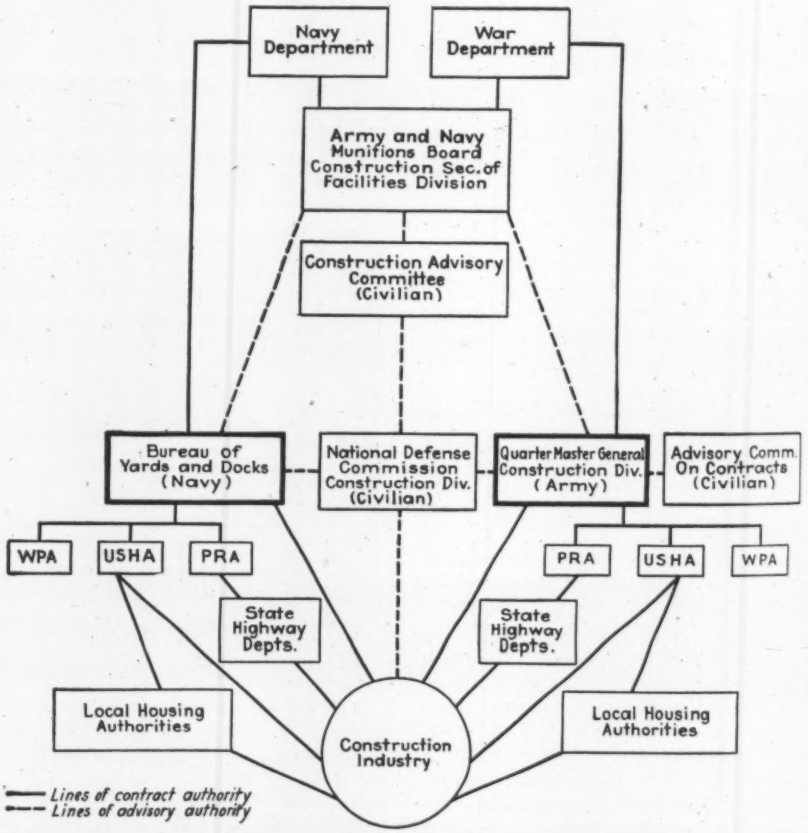
Advisory committee to Munitions Board

Last May, when planning entered the very active stage, the Army and Navy Munitions Board appointed a Civilian Construction Advisory Committee to work closely with its Construction Section. The personnel of this committee, which was announced only July 22, consists of John P. Hogan, president, American Society of Civil Engineers, chairman; Alonzo J. Hammond, president, American Engineering Council; E. J. Harding, general manager, Associated General Contractors of America; E. P. Palmer, past president, Associated General Contractors of America; Malcolm Pirnie, chairman, Construction League of America; and Stephen F. Voorhees, past president, American Institute of Architects. This committee has functioned continuously in connection with the formulation and review of plans connected with the defense program.

Construction in the Defense Committee

At the beginning of the present emergency the President appointed the National Defense Advisory Commission to direct and coordinate the efforts of industry. About July 15, William S. Knudsen, member of the commission in charge of production, organized a Construction Division in charge of W. H. Harrison, who is vice-president and chief engineer of the American Telephone & Telegraph Company.

Set down directly between army and navy construction forces and the construction industry, with its engineers, contractors and materials and equipment manufacturers, Harrison has the job of expediting contracts, of reducing jams and bottlenecks. His office works in close liaison with the Civilian Construction Advisory Committee of the



Contract flow sheet for defense construction and the bodies that have a hand in initiating them

Army and Navy Munitions Board, and with the contract forces of the Quartermaster General and the Bureau of Yards and Docks.

Where the contracts come from

Actual contact of the construction industry with the government will largely be through the Quartermaster General and the Bureau of Yards and Docks. Each of these departments lets its contracts direct, mostly on a cost-plus-fixed-fee basis, but with competitive bids whenever possible.

The Bureau of Yards and Docks, already well into the contract stage on its construction, has developed its organization from among its own personnel. The Constructing Quartermaster General, however, has called in civilian engineers to help guide his construction planning. Chief aide to him is Harry C. Loving, formerly with the Carolinas' Branch of the AGC, who has the title of head of the constructing division in charge of cost-plus contracts. Assisting Loving in negotiating contracts will be a five-man civilian board to which three members have so far been appointed: Francis Blossom of Sanderson & Porter, New York; Forrest Harvey of Quinton, Code & Hill-Leeds & Barnard, Los Angeles; and F. J. C. Dresser of Cleveland.

Heading all Army construction planning, as announced in another item on this page, is Brig. Gen. Richard C. Moore in his new post of deputy chief of staff.

WPA, PRA and USHA

The three other governmental agencies so far connected with defense construction are the Works Projects Administration, headed by Colonel F. C. Harrington; the Public Roads Administration, headed by Thomas H. MacDonald; and the United States Housing Authority; headed by Nathan Straus. Each of these organizations will in turn get its work and orders from the Bureau of Yards and Docks and from the Quartermaster General. WPA will build roads to and in military reservations, and some buildings in army and navy centers. Roads for defense will be translated into construction contracts through the state highway departments, and the new highway act now in Congress will, it is believed, contain provision for the PRA to recommend to the states those roads and bridges that need attention from a military standpoint. When this work occurs on the state highway system, the federal money will have to be matched by the state. No provision has yet been made for other roads but legislation is being prepared which would give the Public Roads Administration money to spend without state matching. Presumably, however, this money would also be handled by state highway departments.

Defense housing plans are still in a state of flux, but legislative provision has been made which will permit the USHA to loan money to local housing authorities without subsidy and without local contributions wherever the housing is designated as necessary to the national defense. Where local housing authorities do not exist, the legislation provides for USHA handling the work direct. Congress will have to appropriate money before USHA can make a good showing.

It is thus clear that contractors will have a number of points of contact with the national defense effort, in so far as construction for the military forces is concerned. First, they will receive contracts directly from the Bureau of Yards and Docks and from the office of the Quartermaster General. They will receive road and bridge contracts from the various state highway departments. And they may receive housing contracts either from the local housing authorities of the various cities or from the United States Housing Authority in Washington.

R. B. Thomson photo

West Coast built-to-order harbor completed

Dedication ceremonies on July 6 marked the completion of a new $1,275,000 built-to-order harbor on the California coast at Hueneme. What two years ago was a bare sand flat is now a first class harbor capable of sheltering all but the largest of ocean-going steamers.

The project, located approximately 75 mi. north of Los Angeles harbor, was financed by a bond issue by the Oxnard Harbor District. Work included excavating 4,000,000 cu.yd. to provide, among other things, a channel 2,500 ft. long, 400 ft. wide and 35 ft. deep; a central basin 1,300 ft. long by 1,100 ft. wide by 30 ft. deep; and a 600-ft. slip 30 ft. in depth. Construction of two rock jetties 1,300 ft. and 1,100 ft. in length; a 1,000-ft. wharf, and a 650-ft. transit shed, besides highway and railroad connections, was also necessary.

Leeds, Hill, Barnard and Jewett, Los Angeles, were employed as consulting engineers to design and to supervise construction, Chas. T. Leeds and Archef F. Barnard acting as designing and constructing engineers, respectively, for the consultants. Forrest S. Harvey, recently appointed to aid Harry W. Loving in his work as head of the constructing branch of the construction division, Quartermaster Corps, U. S. Army, was resident engineer for the work.

The general contract was held by Standard Dredging Co., Los Angeles, Calif., with Rohl-Conolly, Inc., Los Angeles, acting as subcontractor on the breakwaters; McIsaac and Menke, Inc., contractors for the wharf, and shed; Macco Construction Co. for the paving; and Warren Southwest, Inc., placing the revetment and making the railroad extensions.

Additional details of the work are given in ENR, *Oct. 12, 1939, p. 477.*

Moore heads construction on army general staff

The importance of construction and supply in the armament drive was emphasized last week when Brig. Gen. Richard C. Moore, head of G-4, the supply section of the General staff, was elevated to the post of deputy chief of staff, increasing to two the number of deputies. In his previous post Gen. Moore was in charge of planning and policy-setting for military construction, with agencies such as the Quartermaster Corps doing the detailed work. He will now continue in the same field but in closer association with the chief of staff.

Gen. Moore, before transferring to line duty in 1938, was one of the most widely known officers of the U.S. Engineers, his last post having been that of division engineer of the Missouri River Division at Kansas City. Previously he had spent four years in the office of the Chief of Engineers.

WASHINGTON HIGHLIGHTS

AGITATION for a 100 per cent federal program of defense road construction took a set-back last week. Only hope of Congressional action has been that the Army would support such a plan. Secretary of War Stimson, however, took occasion to reiterate at a press conference the Army's traditional position that a good commercial road system is all that is needed for defense. Minor local exceptions to this rule—connections to cantonments and the like—will be handled through WPA.

CONSCRIPTION, if it goes through, is going to increase the volume of military construction work. About $356 will have to be spent on temporary construction of barracks for each man conscripted—and more than a million men will be called up under present plans.

CONSERVATION of the "little waters" upstream can perhaps be overdone. At least the National Resources Planning Board has just initiated a study to find out whether this has occurred on the Gila River in Arizona. Reclamation's Salt River project and the Indian Service's Coolidge Dam on the lower reaches of the Gila are short of water. The Department of Agriculture has built hundreds of check dams and stock-watering pools in the upper reaches, and it is thought the resultant evaporation and soil absorption may be causing the shortage. NRPB has appointed a committee of representatives of Interior, Agriculture, and the Tennessee Valley Authority to find out.

NO REPRESENTATIVE of the construction industry presented any request for modification of the definitions of administrative, executive, and professional employees at the hearings held in Washington last week and this by the Wage-Hour Administration. The hearings, last of a series on this subject, covered the construction, utility, publishing, and miscellaneous industries.

The only statements in relation to engineering employees was presented by the Edison Electric Institute. The institute urged that the definition of professional employee be modified by eliminating the requirement that the employee do "no substantial amount of work of the same nature as that performed by non-exempt employees." It was pointed out that an electrical engineer, for instance, will often work with a subordinate for several days on a particular operation. The institute also would set up a classification of administrative employee (now considered synonomous with executive) which might include many engineers; this would consist of employees exercising judgment and discretion, receiving at least $30 a week, and whose work is such that supervision over their hours is impracticable.

The National Small Business Men's Association proposed to define as an executive any employee paid more than $150 per month.

Unions represented at the hearings, notably the CIO's Federation of Architects, Engineers, Chemists and Technicians and the AFL's International Federation of Technical Engineers, Architects and Draftsmens Unions, opposed any change in the definitions as they now are written.

Philadelphia and Niagara Falls work to Gascoigne

Gascoigne and Associates, consulting engineers, Cleveland and New York, have been retained by the city of Philadelphia to make an investigation and report on the Philadelphia sewage treatment problem. The study is to include recommendations as to type and degree of treatment needed and cost estimates.

Another job recently begun by Gascoigne and Associates is an investigation for the city of Niagara Falls, N. Y., to determine the extent and character of industrial wastes now being discharged into the municipal sewage system. Information as to the effect of the industrial waste upon the character of the sewage is also desired.

JOBS OF THE WEEK

GRADE CROSSING ELIMINATION, New York

Long Island R. R. Co. (A. C. Watson, chief engineer) and Transit Commission, both of New York, awarded the contracts for the grade crossing work on Atlantic Avenue from 92nd St. to Montauk Ave. to P. Tomasetti Contracting Corp., Brooklyn, $2,936,514. Track elevation from Rockaway Park to Far Rockaway (Hammels to Beach 54th St.) was awarded to Charles F. Vachris, Inc., Brooklyn, $2,298,895.

MARINE CORPS FACILITIES, Quantico, Va.

John McShain Inc., Philadelphia, Pa., was awarded contract for aviation and marine corps facilities at Quantico, Va., by Bureau of Yards and Docks, Washington, D. C., $1,460,250, on cost-plus-fixed-fee basis.

CONTROL DIKE, Hartford, Conn.

A. I. Savin Construction Co., East Hartford, Conn., will build a 9,650 ft. dike along Connecticut River from Morgan St. to South Meadow Dike, $1,618,467. Estimated cost was $1,925,000. U.S. Engineers, Providence, R. I. took bids June 23 for this work, a part of the Connecticut River flood-control plan.

SUBMARINE BASE, New London, Conn.

F. H. McGraw & Co., Hartford, Conn. and Spearin, Preston & Burrows, Inc., New York, N. Y., awarded the contract for the waterfront buildings and marine railway at Submarine Base, $2,303,000. Bureau of Yards and Docks, Navy Dept., Washington, D. C., awarded the contracts.

LANDPLANE BASE, Green Cove Springs, Florida

George D. Auchter Co., Jacksonville, Fla.; Duval Engineering & Contracting Co., Jacksonville, and Batson Cook Co., West Point, Ga., awarded $1,800,000 contract on cost-plus-fee basis for auxiliary landplane base on an 800-acre tract between Green Cove Springs Municipal Airport and Shands Bridge by Bureau of Yards and Docks, Navy Department. Work includes landplane hangar, quarters, barracks, power plant, administration building and control tower, gasoline storage and distributing system, roads and utilities.

AMMUNITION MAGAZINES, Savanna, Ill.

Manhattan Construction Co., Muskogee, Okla., will construct 44 standard ammunition magazines for Constructing Quartermaster, Savanna Ordnance Depot. $1,452,850.

SUB-ASSEMBLY SHOP, ETC., Brooklyn, N. Y.

Walter Kidde Constructors, Inc., New York, awarded a $1,520,000 contract for a sub-assembly shop, shop building improvements and steel storage runway at New York Navy Yard by Bureau of Yards and Docks, Navy Department.

CHANNEL IMPROVEMENTS, York, Pa.

Benjamin Foster Co., Philadelphia, Pa., awarded $1,631,373 contract for constructing flood control works for protection of the city of York, including Codorus Creek improvements. The work includes 990,000 cu.yd. common and 130,000 cu.yd. rock excavation; and 785,000 lbs. reinforcing steel. U. S. Engineers Office, Baltimore, Md., took bids. The same contractor was awarded the Indian Rock Dam on main branch of Codorus Creek in January 1940 on a bid of $1,206,104.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appears in the Construction News Section beginning on page 101.

Knudsen makes first report on survey of construction needs

Reveals that second of federally-owned ordnance plants to be built will be for shell-loading

An over-all survey of the construction needs of the War and Navy departments has been undertaken by the National Defense Advisory Commission, William S. Knudsen, head of the commission's production section, announced last week in his first progress report to the nation. This survey, as pointed out in (*ENR*, July 25, 1940, p. 123) is being carried out by W. H. Harrison, Knudsen's construction aide.

Knudsen revealed that the second of the federally-owned ordnance plants to be built will be a shell-loading plant, on which negotiations are well underway. It was not revealed where the plant will be located, but in view of plans to build up five self-contained ordnance districts in the country, it is thought likely it will be near the recently-announced $25,000,000 smokeless powder plant at Jeffersonville, Ind.

Also announced were early plans for expansion of five small shipyards on the Gulf and Pacific coasts.

Knudsen now believes, after conferences with turbine-builders, that expansion of capacity for manufacture of steam turbines can go forward fast enough to avert the threat of a shortage (*ENR*, July 25, 1940, p. 126) without imposition of priorities. It had been feared that huge demands for steam turbines as a result of the Navy expansion might interfere with supplying the needs of the public utilities and might even cause trouble for users of water turbines.

Although widely publicized, British proposals that an airplane capacity of 3,000 planes a month be built up here for British use, in addition to present plans, meet with little encouragement in America. Knudsen has surveyed the possibilities, at the request of the British Purchasing Commission, and has found that such a program would require the construction of 38 manufacturing plants. He makes no estimate of cost, but other sources indicate that something like a billion dollars would be required.

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Engineering Institute abolishes associate grade

By an almost unanimous vote, on one of the largest ballot returns ever received, the Engineering Institute of Canada has abolished its grade of associate member. Although this change has been under discussion for some years, having been included in the proposals of the institute's committee on consolidation four years ago, the present action results from a recommendation of the council of the institute at the annual meeting of 1939. In the ballot that has just been canvassed, 1,368 ballots were cast for the proposal and 83 against. All former associate members of the institute automatically become members.

This action was taken to facilitate close cooperation between the institute and the professional associations of the provinces, which are the legally recognized bodies to which all engineers must be admitted before they can practice. Two of these associations already have entered into agreements with the institute whereby their members automatically become members of the institute as they are admitted to the professional association.

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Quarter billion proposed for defense housing

The U. S. Housing Authority would be empowered to borrow an additional $250,000,000 for use on defense housing projects under a bill reported out by the House naval affairs committee last week. The money could either be turned over by USHA to Army and Navy, or it could spend it itself or through its local housing authorities.

Construction contracts for defense housing could be made by negotiation on a cost plus a fee basis if the bill passes in its present form. USHA officials hope to continue using lump sum competitive contracts, but they want this additional authority in case delays should arise.

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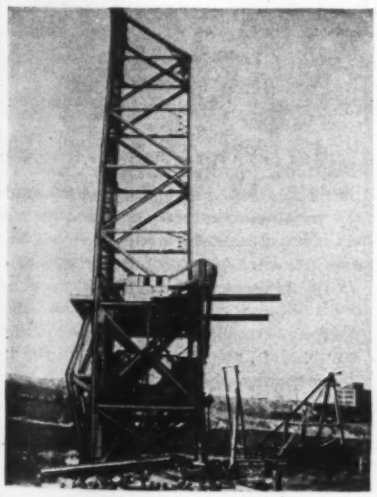
Former road official appeals case

Appeal of a one year jail sentence and a fine of $3,000, which followed a superior court conviction of payroll padding, has been made to the Pennsylvania State Supreme Court by Roy E. Brownmiller, former state secretary of highways of Pennsylvania. Brownmiller, charged with falsification of payroll records for a State highway project in Luzerne County while he was head of the highway department, was found guilty June 25, 1939.

Dynamite brings down Cleveland bridge in way of river straightening work



Forty pounds of dynamite encased in concrete in the four legs of a tower of the Wheeling and Lake Erie Ry. lift bridge over the Cuyahoga River at Cleveland successfully razed the structure when fired simultaneously late in June. The diagonal bracing in the tower had been cut away previously. The span, counterweight and tower of the 35-year-old, single track, Strauss trunnion bridge fell exactly as planned or on the river bank along the line of the approach trestle which had been removed. Before the blast the end of the bridge stood 185 ft. above the water.

The bridge was purchased by the city of Cleveland as part of the $5,500,000 river improvement and was removed to make way for a major cut. It was located a short distance upstream from the new West Third St. crossing.

Merritt-Chapman & Scott Corp., Verton L. Rock, superintendent, did the work.

Civil engineers meet

(*Continued from p. 29*)

the lowest grade salaries. The Board authorized further salary surveys.

The Freeman Scholarship of $2,000 was awarded to H. G. Dewey, Jr., Denver, Colorado. He will visit hydraulic laboratories in the United States.

The address of the president, John P. Hogan, was devoted largely to national defense. The question of engineering personnel for the army, said Hogan, may soon become of moment (the German army is reported to have 14 per cent engineering troops), and an immediate increase in existing forces from 7 to 10 percent is contemplated.

John C. Page, commissioner, USBR, opened the technical meeting giving a broad view of reclamation. He was followed by E. B. Debler, hydraulic engineer, USBR, on proper planning, and a paper on "Project Construction" by J. L. Savage, chief designing engineer, USBR, was read by K. B. Keener, designing engineer on dams.

Structural engineering

Two papers comprised the program of the structural division. The first, by M. A. Seiler on a "New Solution of Stresses in Circular Plates," presented a set of curves giving the deflections, shears and radial and circumferential moments in circular plates with a control circular opening, for various types of loading and for various boundary conditions.

The second paper, by R. E. Glover, dealt with methods developed at the bureau for the determination of modes of vibration of structures subjected to earthquakes. The use of the torsional pendulum to facilitate mathematical computations was illustrated, and results obtained for the Boulder Dam intake towers and Pitt River Bridge piers in California were presented. Since both men are USBR engineers their papers will be published in the form of technical memoranda of the bureau.

Another paper of structural character, presented in the highway division meeting by Maurice Hausecroft, bridge engineer of Utah, outlined developments in bridge engineering in the West. Although largely descriptive of structures familiar to the readers of this journal, the paper also presented a method of determining fixed end moments for beams of variable moment of inertia as used by the Utah bridge department.

Seepage in earth dams

O. N. Floyd, consulting engineer, Dallas, Tex., and chairman of the committee on cores, cutoffs and impermeazation presented conclusions which he indicated are justified at this time. They are as follows:

The function of a core is the same in any type of earth dam and its requirements can be met by proper sorting, mixing, placing and compacting of the most suitable material found nearby. If suitable material to prevent seepage is unavailable it is often just as satisfactory to permit seepage and provide proper drainage. No satisfactory and economical chemical treatment to render pervious material impervious has been developed. Laboratory tests can determine "with a fair degree of dependability" the safe volume of seepage.

The only practicable impervious cutoffs are made by excavating to an unbroken impervious structure and inserting a suitable waterstop of compacted earth, concrete or metal up to the core. If proper provision for the collection and disposal of seepage is made, and if the loss is of no consequence, a fair volume of seepage can be permitted. Steel sheet piling up to 75 feet can be used with satisfaction; beyond that length splits and curls are likely.

Benjamin K. Hough, Jr., U. S. Engineer Office, Binghamton, New York, presented a thought-provoking paper on "Types of Earth Dams" in which he suggested exploring the materials available prior to attempting the design. This is the reverse of the usual procedure followed, and it was contended that not only is it more logical but that it would foster the necessary development of new types of earth dams. In discussion K. B. Keener, designing engineer of dams, USBR, indicated that earth dam design might well be altered so far as the variable zones are concerned. While commending an idea of interior drainage, advanced by Hough, he warned that one must be sure the pervious portion of the dam does not become filled as time goes on, thus changing its characteristics.

Soils mechanics

Much of the soils mechanics program dealt with procedure to get undisturbed samples.

The work of the sub-committee on structural design of embankments and foundations is to be facilitated, according to T. A. Middlebrooks, senior engineer, USBR, by the distribution of a section of an embankment to various laboratories throughout the country for stabilizing studies. Results are to be analyzed by the committee.

Conclusions of the committee on consolidation of embankment and foundation materials related to factors affecting the control of soil density; methods of compacting soils; and to gages for recording settlement, water pressure, and soil pressure. A settlement of 2 ft. and a saving of $90,000 was effected by the use of explosives in the terraces of the Franklin Falls damsite on the Merrimack River in New Hampshire, according to Col. A. K. B. Lyman, Corps of Engineers. The operation resulted in a decrease of permeability and void ratio and an increase in compaction. Similar operations have been carried out at the Denison damsite in Texas and in the Binghamton (NY) engineer district.

Soils mechanics extended into the highway division when R. W. James, associate highway bridge engineer, U. S. Public Roads Administration, presented an unusually complete paper on a rational method of analyzing highway fills. The paper adapts for highway soil structures the analysis of the soil characteristics (density, modulus of compressibility and permeability) made by J. H. A. Brahtz, engineer physicist, USBR, and intended for earth dams. The practical applications include the use of the stress equations, together with a complete solution using the necessary pore pressure charts, as developed in USBR Technical Memoranda 592.

Models for hydraulic studies

Model studies formed a part of several papers before the hydraulics division. Conformity between model and prototype of the spillway flow over the Madden Dam is remarkably consistent, according to Philip S. O'Shaughnessy, engineer, Panama Canal. Jacob E. Warnock, hydraulic engineer, USBR, described the use of models in designing the outlets of Grand Coulee Dam. The behavior in the field structure, so far as can yet be determined, compares favorably with the 1:120 model used in the laboratory investigation.

"Silt Problems of the Imperial Dam and the All-American Canal," a paper by C. P. Vetter, engineer, USBR, historically reviewed the silt observations of the Colorado River before and after Boulder and Parker dams were built, plus the problem of removing 70,000 tons of silt per day at Imperial by mechanical means. In discussion R. L. Parshall, senior engineer, Soil Conservation Service, Fort Collins, Colorado, described by means of models, the use of riffles and vortex sand tubes to remove the bedload of sand and gravel from canals.

S. P. Wing, civil engineer, USBR, described, hydraulic tests made on Boulder Dam penstocks and compared the results with those obtained on models. Measurements made by pitot tubes and pressure gages of water flowing at 90 fps presented numerous physical difficulties, and results indicate that extrapolations to determine friction factors are inadvisable. Traverses indicate that the roughness is somewhat equivalent to that of a lining of ⅛ in. pebbles, although the penstocks are lined with asphalt, and a 20-ft. straight edge showed only ¼-in. variations.

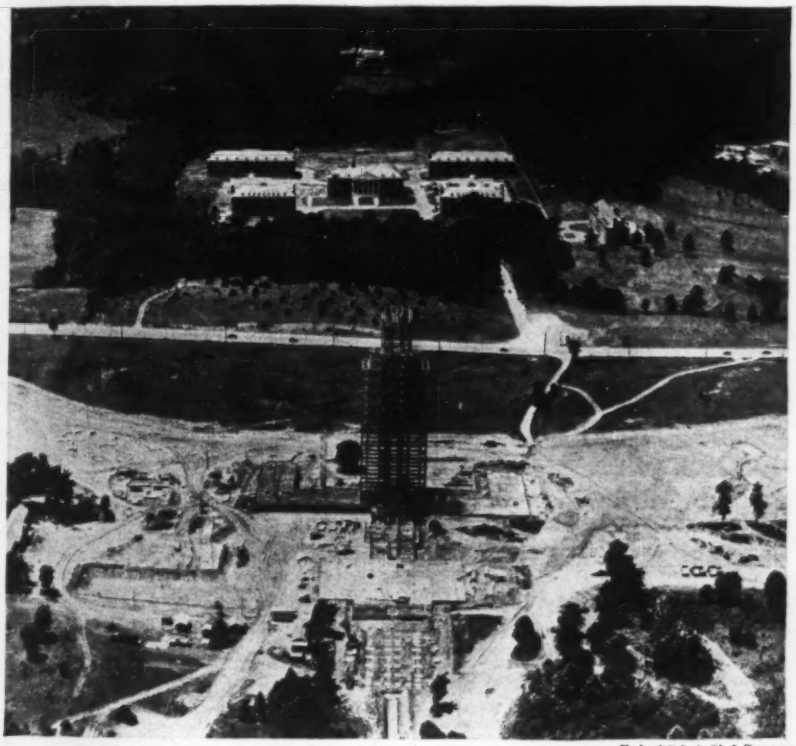
Three-quarter billion needed for additional naval bases

Of this amount $96,000,000 is authorized by a bill now in Congress. Construction to be during next five to seven years

The 70 per cent expansion of the Navy, already approved by Congress but for which no money has been provided, will necessitate construction of shore facilities costing at least $750,000,000. This was pointed out by the House committee on naval affairs in its report on a bill which would authorize $96,000,000 of navy facilities.

No start has yet been made on providing bases for the two ocean navy contemplated in the expansion bill; the facilities authorized in the present bill are to meet existing needs. The expanded navy will be constructed over the next five to seven years, so the three-quarter billion will not all be spent at once. However, the committee emphasizes that if the entire program of shore structures was started now they would not be ready much before they were needed. It is not unlikely, therefore, that considerable sums may be appropriated within the next year.

The present bill authorizes an appropriation of $25,000,000 for expansion of navy and marine training facilities, authorizes $3,750,000 of work at the San Diego destroyer base and $3,000,000 at the Guantanamo, Cuba base. Otherwise the authorizations cover a multitude of comparatively small improvements.



Fairchild Aerial Survey

Special requirements influence design of Naval hospital

Pyschotherapy dictates design in this $4,850,000 Naval hospital under construction at Bethesda, a suburb of Washington, D. C. Although the hospital is located on a 265-acre tract, much of the mass is concentrated in a 20-story tower 250 ft. high to provide quiet, sunlight, and a restful outlook for the patients. The tower will be topped by an airplane beacon; the wings will be three and four stories high.

Precast exposed-aggregate slabs—a decorative material used extensively by the Navy on its model testing basin near Washington—will be used for trim throughout the main building and for structural outside finish.

Construction of the building was begun in June of last year, and it is scheduled for completion in December, 1941. Except for steelwork, contracted by American Bridge Co., the building is being erected by John McShain, Inc., Philadelphia. The hospital was designed by the Bureau of Yards and Docks with the architectural consultation of Paul Cret.

Buildings across the road in the background form the newly-completed National Institute of Health.

Ickes to delay action on Hetch Hetchy power case

Harold L. Ickes, Secretary of the Interior, and Mayor Rossi of San Francisco have come to an agreement whereby Ickes will recommend to the federal court a stay until Oct. 1 of a court injunction to stop the sale of Hetch Hetchy power by the city to the Pacific Gas & Electric Co. (On April 22 the U. S. Supreme Court ruled that San Francisco violated the Raker Act through sale of power developed on the Hetch Hetchy Aqueduct to a power company instead of direct to consumers. *ENR*, April 25, 1940, p. 562.)

The city is working on a proposal whereby it would either lease or buy the distribution system of the P. G. & E. in San Francisco and operate it with municipal employees. If the present negotiations for a lease of the P. G. & E. distribution system fails, a bond issue authorization is being prepared for submission to the public to permit outright purchase of the facilities.

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Tacoma bridge oscillations being studied by model

The University of Washington engineering department at Seattle has undertaken a study of the vertical oscillation of the deck of the Tacoma Narrows suspension bridge, seeking to discover means of reducing the movements, which were observed even before completion of the structure and have given the engineers much concern. They are believed to result from wind action.

Measurements show that the bridge floor rises and falls over a maximum range of $2\frac{2}{3}$ ft.; very little side sway has occurred. According to L. V. Murrow, Washington state highway engineer, under whose direction the bridge was built, the safety of the structure is not affected. However, some persons are reported to have become seasick because of the oscillation.

Motion pictures show an up-and-down movement similar to gentle waves on water, readily seen from either shore. Experiments are to be conducted on a scale model of the bridge, which has been equipped with devices to cause the model to simulate this rippling action, and damping devices of various kinds will be tried out.

The Tacoma bridge is the narrowest long-span suspension bridge ever built; the cables are only 39 ft. apart and the roadway is 24 ft. wide, though the main span of the bridge is 2,800 ft. long, third largest in the world.

Traffic over the bridge during the first two weeks of operation was double what had been expected by the engineers; $36.214 was taken in at the toll gates.

OBITUARY

DAVID WATSON TAYLOR, 76, who retired in 1923 after 43 years of service on construction for the U. S. Navy, died in Washington, D. C., July 28. Taylor, a graduate of the U. S. Naval Academy at Annapolis, and Royal Naval College at Greenwich, England, was appointed chief of the bureau of construction and repairs of the U. S. Navy in 1914.

GUY W. COBB, 55, civil engineer employed by the New York Central R. R. for the last 21 years, died in Tarrytown, N. Y., July 21. Cobb, a graduate of Norwich University, during the World War served in France with the 102d Engineers, advancing to the rank of major.

WADE BARNETT, 64, engineering graduate of Tulane University for 35 years connected with the New Orleans Sewerage and Water Board, died in New Orleans July 23. Between 1917 and 1920 he was on leave of absence to work on the design of pumping stations at Chicago, Evanston, Des Plaines and Calumet, Ill.

GEORGE C. EVANS, 63, former superintendent of construction for the Raritan Copper Works, died July 27 at Southern Pines, N. C. For many years he was engineer for the Anaconda Copper Co. in Montana.

E. G. HUNT, city engineer of Aberdeen, Wash., from 1921 to 1925 and from 1928 to 1931, died July 21 at Chehalis, Wash.

WILLIAM A. MACNELLY, 49, sanitary engineer employed by Charles Hurd, consulting engineer, died at Hammond, Ind., office July 20. MacNelly, who attended the University of Illinois, had spent the last several months in designing a $3,000,000 sewage system for Hammond.

JOSEPH-TETU BERTRAND, 76, retired civil engineer and former chief engineer for the Quebec government in Gaspe, died July 21 at his home on the Isle Verte near Riviere du Loup, Quebec.

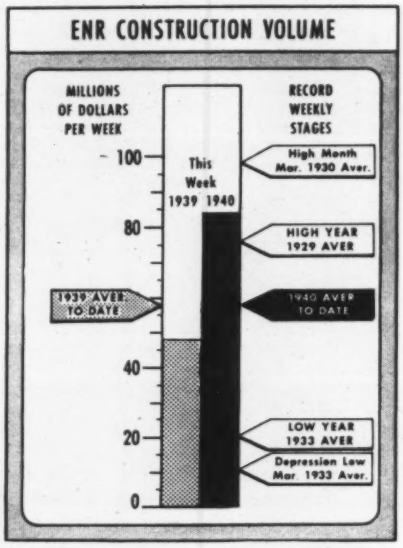
GUY LINDLEY, 68, engineer in charge of the city waterworks at Union City, Ind., died July 17.

JOHN S. TURNER, state highway and maintenance supervisor in the Gadsden District for the Alabama State Highway Department, died in Gadsden, July 26.

D. P. GAYMON, 80, city engineer of Pueblo, Colo., for 30 years before retiring four years ago, died July 26 at Portland, Ore.

CONTRACTS AND CAPITAL

THE CONTINUATION of defense construction spending brings the 31-week 1940 construction volume to $1,827,070,000, a level 2 per cent above the total reported for the corresponding 1939 period. Federal construction, the prime mover in the spurt, totals $417,084,000, and is 136 per cent higher than a year ago. Private construction, $567,182,000 tops last year by 24 per cent, but the total public figure, $1,259,888,000, is 6 per cent below the 1939 volume.



The current week's awards, $89,602,000, are the fourth highest of the year, and top last week by 71 per cent and last year by 89 per cent. This is the fourth successive week that 1940 values have exceeded their respective 1939 volumes. Private awards are up 13 per cent over a week ago, but decline 17 per cent from a year ago. Public construction is 90 and 149 per cent higher, respectively, than last week and last year.

All classes of construction work except waterworks gain over their last week's values. Comparisons with a year ago show gains in sewerage, bridges, commercial building and large-scale private housing, public buildings, earthwork and drainage, streets and roads, and unclassified.

New capital for construction purposes for the week totals $21,257,000, a decrease of 6 per cent from the volume for the corresponding week last year. The current total is made up of $11,854,000 in USHA loans for low-rent slum-clearance projects, $7,559,000 in state and municipal bonds; $1,788,000 in corporate security issues, and $56,000 in RFC loans for public improvements.

New construction financing for the year to date, $1,721,063,000, is 4 per cent below the 31-week period last year.

Engineering Construction Contracts Reported by Engineering News-Record, in July, 1940

Engineering News-Record *reports projects of the following minimum costs: water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States July 1940	United States Seven Months 1940	United States Seven Months 1939	Canada
Waterworks	1,325	611	562	440	1,838	3,867	**8,643**	47,879	118,135	110
Sewerage	68	1,628	1,120	1,574	892	821	**6,103**	51,054	105,049	55
Bridges, public	170	2,761	969	2,005	1,408	740	**8,053**	58,734	97,850	1,030
Earthwork and waterways	211	2,355	5,739	889	6,222	4,509	**19,925**	144,746	116,838	986
Streets and roads	3,599	10,337	9,396	12,303	14,214	4,281	**54,130**	418,171	392,477	2,682
Buildings, public	7,304	13,931	8,268	31,497	3,533	18,357	**82,890**	259,157	374,631	10,575
Unclassified, public	27,699	13,271	42,291	1,858	2,769	16,670	**104,558**	209,933	100,843	18,709
Total public	**40,376**	**44,894**	**68,345**	**50,566**	**30,876**	**49,245**	**284,302**	**1,189,674**	**1,305,823**	**34,447**
Federal government (included in above classifications)	29,676	20,582	51,682	32,002	6,227	37,048	**177,217**	392,648	174,704	.....
Private										
Bridges, private	625	659	.....	.....	.....	.....	**1,284**	9,755	2,752	.....
Buildings, industrial	1,142	5,113	4,420	4,011	1,719	3,117	**19,522**	241,975	119,003	2,865
Buildings, commercial	1,565	14,710	3,072	1,810	850	2,188	**24,195**	220,600	211,951	760
Unclassified, private	277	1,094	14,420	3,978	2,539	1,241	**23,549**	80,464	105,164	70
Total private	**3,609**	**21,576**	**21,912**	**9,799**	**5,108**	**6,546**	**68,550**	**552,794**	**438,870**	**3,695**
Total Engineering Construction:										
July, 1940 (4 weeks)	**43,985**	**66,470**	**90,257**	**60,365**	**35,984**	**55,791**	**352,852**	.....	.....	**38,142**
June, 1940 (4 weeks)	18,296	62,923	40,765	40,741	60,252	29,786	**252,763**	.....	.....	19,460
July, 1939 (4 weeks)	6,418	56,630	26,945	35,753	33,930	21,793	**181,469**	.....	.....	21,315
Seven Months — 1940	113,772	420,327	366,075	311,183	314,691	216,420	.....	1,742,468	.....	112,984
Seven Months — 1939	92,599	570,490	268,154	332,362	312,030	169,058	.....	.....	1,744,693	65,627

COMMENT AND DISCUSSION

Readers' opinions on matters that concern engineers and contractors

Emergency Contracts

Advance proofs of Louis B. Wehle's article on emergency construction contracts, which is published in this issue, were sent to a number of government officials and others concerned. Several of these called attention to additional facts or expressed views on emergency contracts as contained in the following extracts from their letters.—EDITOR.

Sir: Mr. Wehle's statements comparing the industry today with that of 1917 are not in accordance with the facts. He states that "In the 20 years before 1917 the American construction industry had seen a steady expansion, and there were in existence a far larger number of financially strong, well organized contractors than today." The facts are that never prior to 1917 did the construction industry have anything like the volume and consequently the capacity that it had in later years. The skyscraper era and the construction of highways of high type were just beginning to be thought of. The development of power was in its infancy, as were also flood control and irrigation. There were no Boulder and Coulee dams, Empire State buildings or Golden Gate bridges constructed prior to 1917, but the contractors of the nation were able to handle all of these projects without difficulty.

While it is true that the volume of construction fell tremendously with the depression it has been on the increase for the last four or five years, and there has been no dearth of competition for projects of any size or character. Already the War Department has received applications for consideration from more than 1,400 contracting organizations that have filed applications as individual companies and have also formed their own companies. I am certain that the American construction industry can handle any construction program which the defense needs of the nation require, and take it in stride and without need of any type of regimentation.

As for the fixed-fee basis of handling this work as compared with the percentage fee, the fact remains that the law prescribed a fixed fee. However, a clause in the recently released contract form of the War Department will show that it is contemplated that the fixed fee is subject to adjustment where changes cause a material increase or decrease in the amount or character of the work to be done under a contract or in the time required for its performance.

EDWARD J. HARDING
Managing Director, Associated General Contractors of America, Washington

Sir: The outline of experience with emergency defense construction contracts in 1917-18, the conclusions drawn therefrom, and the suggestions made in the light of that experience, are of special interest and importance at this time. Mr. Wehle's paper merits the serious consideration of the Washington officials in charge of the emergency defense construction work about to be begun.

FREDERICK HOITT
Secretary, New England Road Builders Association Boston

Sir: No more timely advice could be given to contractors at this particular time than Louis B. Wehle's discussion of government contracts during the war emergency.

G. W. MAXON
General Contractor, Dayton

Sir: In the award of emergency construction contracts it is possible that small and medium sized contractors are not receiving a fair share of the work. Many of them are just as capable within their own sphere and at least as sound financially as are the big national concerns. Certain large contracts can be handled more readily by one large contractor than by a number of small ones, but in other cases smaller separate contracts can be awarded without loss of efficiency, and perhaps with a gain.

Further, modern military equipment can be produced in sufficient volume only when the work is backed by a high degree of morale, and anything contributing to increased confidence in the wisdom and impartiality of government will strengthen morale. Contracts entrusted to a thousand rather than to a hundred different concerns would have a favorable influence in this direction.

W. D. DEAN
General Manager
Bureau of Contract Information
Washington

Idea for Defense

Sir: Observation of tractors equipped with "bulldozer" or timber rakes leads to conviction that operator's seat should be on front end of machine. From this position he could see where he is going and better judge quality of work.

The rear seat is only a hangover from horse and mule days and seemingly has little to commend it.

As a defense expedient, either could be supplied with steel hood to set down over whole machine and, if equipped with machine gun or one-pounders, would make very acceptable tanks. A few of these in any locality would be the answer to any force landed from planes.

FRANK B. KING
Civil Engineer
Oklahoma City, Okla.

Gravel or Cement?

Sir: If it is essential that gravel, gravel of sedimentary origin, must be used, it would seem that the problem is not one of getting the poor material out, but one of protecting the material after it is in use. Of course, if the project cannot absorb the cost of selected aggregate, the problem is one of keeping the water out of the concrete after it is in place and hardened.

My observation has been that trouble from frost, regardless of the aggregate, does not come from the water, residual in the concrete after hardening, but rather from that which has infiltrated after hardening. So why study 10,000 sources of gravel when you only have 200 sources of cement of which, if we can believe what we are told, there is only one kind, so it is a 10,000-to-1 shot that we might find the trouble in the cement?

This is comment on C. E. Wuerpel's article, *ENR*, May 9, p. 80.

CHAS. L. KIRK
Vice President
Eddystone Portland Puzzolan Cement Co.
Pittsburgh

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August 1, 1940

LAST YEAR we predicted that construction volume would exceed that of 1938 by 11 per cent. The actual increase was just 11 per cent. This year we tried again, and thought 1940 would be about 1 per cent under 1939. For the first thirty weeks of the year we are exactly right. Reminder is made of this estimate at this time because it may be painful to bring it up later; the way contracts are being let for defense construction, 1940 will soon pass 1939. Good now, our prediction seems doomed to be a bad underestimate. It was at best only a carefully considered guess. And we had never been up against Hitler before.

Sawhorses and Nose Thumbing

IT IS HARD TO BELIEVE but it's true. A job on two new office buildings in Washington, being rushed to completion for occupancy by the War Department and the National Defense Commission, was shut down recently because of a jurisdictional dispute between carpenters and plasterers' helpers over who would build some sawhorses. Not the carpentry work, just some sawhorses. Not a new building for a haberdashery shop, but emergency quarters for the U. S. War Department. The gift of labor leaders to force their men to do the wrong thing at the wrong time was never better illustrated. Besides stopping emergency construction, the strike was also significant because it involved nose thumbing at the dispute settling machinery of the AFL's Building Trades Department by the carpenters, who refused to accept the decision of the dispute board that the plasterers' helpers should build their own sawhorses. The situation is full of danger signals. Is labor ready to scuttle its dispute-settling machinery that has worked so well for over a year? The construction industry, including labor, will be the loser if it is. Is labor going to regard the defense emergency so lightly that it will stop important jobs just to emphasize unimportant principles of work jurisdiction? If it is, the whole nation stands to lose. The sawhorse and nose-thumbing episode in Washington should be repudiated by the top leaders of the AFL. Otherwise, Congress is apt to underline "labor" on its program listing things that something should be done about.

Credit to PWA

THE PWA finished its season with a batting average of 0.883. For such a splendid record great credit is due a great many people from the topmost administrators in Washington to the smallest subcontractor and his men. On July 1, 1940, the deadline, there remained only 11.7 per cent of the billion and a half dollar program incomplete, and only 4.9 per cent or 300 of the 6,156 projects that were begun 18 months ago had work remaining to be done. These 300 projects, moreover, were the big jobs that everyone knew from the beginning could not be disposed of in the time allotted. Congress has decreed that PWA is over. But before it becomes the prey of historians, who may or may not judge it fairly, it is well to emphasize that in its final trial, when it was neither playing second fiddle to NRA nor struggling in competition with an unbridled WPA, the financing of local public works by federal grants-in-aid proved an outstanding success. If it did not entirely rout the depression, it used public money efficiently; it gave as much needed employment as any other device used; and, what may prove to be its most vital contribution, it kept a large segment of the engineering and contracting forces of the nation in training and intact for the great national defense effort upon which we must now embark.

Defining Wage-Hour Groups

RULING of the New York wage-hour board with respect to engineering employees of the Lummus Co., (*ENR*, July 25, p. 123) helps to clear up some of the uncertainty that has surrounded the question of the extent to which the wage-hour act applies to engineers and engineering employees. The ruling states that checkers who do routine work under a squad boss are not doing "professional work" as defined by the wage-hour act. Similarly, designers who do drafting under supervision and at a stipulated hourly wage are held to be covered by the act. This does not go as far as representatives of the Federation of Architects, Engineers, Chemists & Technicians urged the wage-hour administration to go at the hearings in Washington. Coming at this time, the finding of the New York director may well indicate that the Wage-Hour

Administrator in Washington is not going to take such an extreme attitude toward this question as the unions would like. And as a matter of fact, the act was only intended to prevent the exploitation of the low-paid groups in industry, which include such men as checkers, draftsmen and some designers, and was not planned to cover the higher-paid groups who need no such protection. The findings of the New York director are in line with this understanding of the purpose of the act.

Army Construction Next

EACH BRANCH of the armed forces now has a slogan—given to it gratis either by administration leaders or by phrase-coining journalists—to characterize its national defense effort. First it was "50,000 airplanes" for the air service. Next came the "two-ocean navy." And now we have "a million more men under arms" to epitomize the Army's objective. As phrases the slogans are admirable, as representing official intentions they are reasonably accurate, but in each case there is implied a rapidity of attainment that is false; before we can really start turning out planes, ships and soldiers, there is an immense amount of preparatory work to be done. And much of it devolves on the construction industry.

So far engineers and contractors have been allowed to get their teeth into only the aircraft and naval construction problems. The Army's construction program, which is not yet under way, provides the big question mark.

The War Department's slowness in giving the right-of-way to construction apparently goes back to the policy attending the industrial mobilization plan over the past half-dozen years. It was a part of this policy to ignore detailed construction planning because it was felt that the construction industry could pitch in almost overnight on any problem that might be presented to it. Complimentary though this was, it was hardly realistic, and the policy now works a hardship on the Constructing Quartermaster General, whose office and planning have had to be reorganized on short notice.

The one thing that is certain is that Army construction is next on the program and that when it arrives it will test the mettle of the construction industry. Even to provide enough barracks by winter will be a herculean job. But the objective, stated in the "million men" slogan, is plain. The spade work is up to the construction industry.

Emergency Contracts

NATIONAL defense construction work has begun on a large scale and will shortly attain huge proportions. Its urgency is extreme, and for this reason it involves requirements far beyond those of normal construction. Time cannot be taken for competitive bidding, yet the work must be done at lowest cost and greatest speed and with unquestioned sureness of result. It is of such volume and complexity, moreover, that the full resources of the construction industry need to be drawn upon.

Under these conditions it is important to ask what previous work of similar kind can teach as to best procedure. Louis B. Wehle's review, elsewhere in this issue, of World War construction experiences gives the result of such inquiry.

Why, one may ask, should the contract method be used? Why not direct construction by government forces? A conclusive answer is that only the contract method will make available the full skill and resourcefulness of experienced construction men. For the same reason, able specialist subcontractors can contribute vitally to the success of the work. The problem is to devise such contract arrangements as will effectively make both contractor and subcontractor partners of the public. And this must be accomplished whether the work to be built is such that it can be fully planned in advance or whether—as is true of a large part of defense emergency construction—its scope and cost can only be estimated at the time the contract is let.

Existing law authorizes fixed-fee contracts for the emergency construction, but prohibits variable fee or percentage contracts. During the World War some fixed-fee contracts of necessity became variable-fee contracts, but under present law such transformation is prohibited. The question that Army and Navy have had to consider is how fixed-fee contracts can be applied successfully to work whose scope may be greatly enlarged while in progress.

Special forms of contract have been worked out to meet the situation. Though their success in actual operation remains to be demonstrated, it is to be hoped that they will meet all vital requirements of the defense emergency. If, however, they are found inadequate to cope with all the difficulties, no time should be lost in removing the present limitation on contract form. It would be better still to amend the law at once, in order to forestall possible unsatisfactory experiences and the delay of subsequent remedial legislation and to leave contracting officials free to adopt in each case the procedure best suited to their requirements.

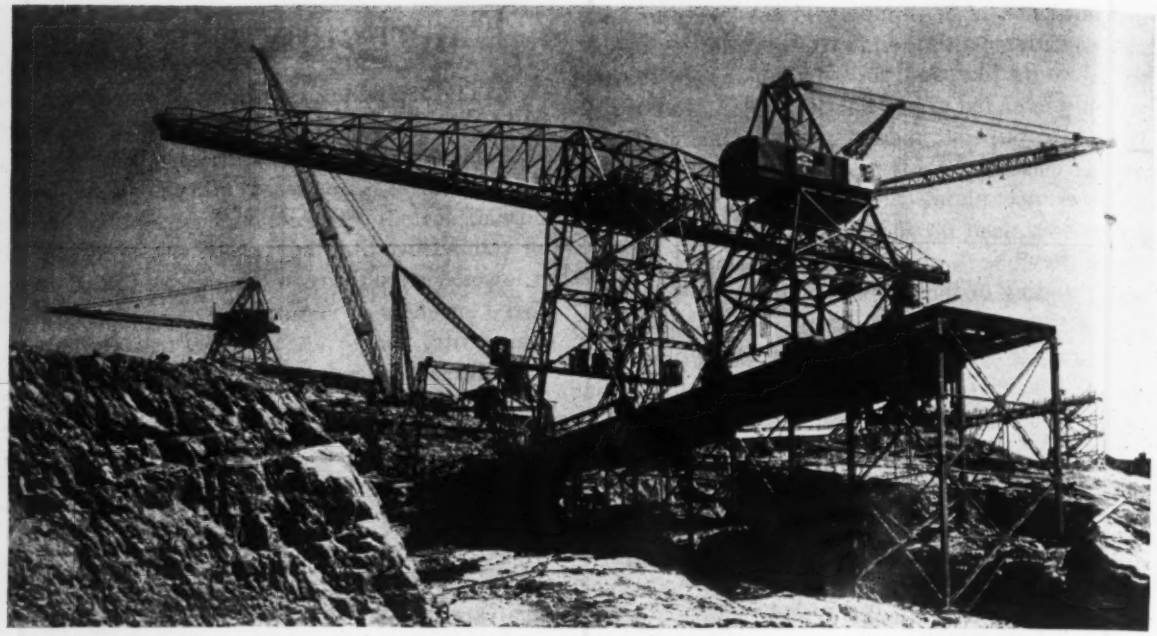


FIG. I. HAMMERHEADS AND REVOLVING DERRICKS AT FRIANT DAM WILL PLACE TWO MILLION YARDS OF CONCRETE.

How Friant Dam Is Being Built

Contents in Brief—Construction plant for world's fourth largest dam includes means for economic handling of aggregate and simultaneous discharge for 7-car train of 65-cu. yd. bottom dump cars; also a high steel trestle on which all concrete goes out at one level under fast hammerhead cranes and revolving derricks. Ice machines cool mixing water, and a 20 per cent pumicite admixture is used with low-heat cement.

FRIANT DAM, companion structure in the Central Valley Project to Shasta Dam on the Sacramento River, is located 20 miles north of Fresno, Calif., on the San Joaquin River. Of concrete gravity type, straight in plan, 3,340 ft. long and 325 ft. high, its 2,000,000-yd. concrete volume will be exceeded only by Boulder, Grand Coulee, and Shasta dams. The 520,000-acre-ft. reservoir includes 70,000 acre-ft. for flood control and 316,000 acre-ft. for irrigation. Time allowed for construction is 1,200 days (3¼ years) starting Nov. 1, 1939. The general contract for $8,700,000 covers only actual construction, i.e. construction plant, labor, and management. Materials for the permanent work, except aggregate produced at the site, will be furnished by the U. S. Bureau of Reclamation at an estimated cost of $7,300,000, making the total cost of construction over $16,000,000. The unit price system prevails, and payments to the contractor will be made from monthly estimates on 76 bid items.

The size of the concrete job places a premium on economy in all stages of concrete manufacture and placement. Quantity production ideas have governed the layout of construction plant from gravel pits to forms. An unusual effort has been made to balance performance all along the line and, where possible, to provide reserve capacity as a continuity safeguard. In placing concrete in the dam there is special inducement for high performance as this operation is the one which records progress. Here the contractor is using cranes of the hammerhead and revolving type in a combination which has exceptional advantages.

Excavation at the site will amount to about 1,220,000 cu.yd. to expose the bedrock. River diversion was somewhat delayed by the uncovering of a bedrock seam, actually a fault zone, 100 ft. wide but too old geologically to menace the structure; otherwise the job has progressed considerably in advance of the contractor's time estimate. Concrete placing will be slow at the start and some two months may be required to put in the first 40,000 cu.yd. Equipment is planned for a maximum capacity of 250,000 cu.yd. per month with an average placement of 150,000 cu.yd., expected to be reached some time this fall.

Gravel pit and plant

Sand and gravel come from a deposit 30 ft. deep in an area of 190 acres on the left bank of the San Joaquin River 2½ miles below the dam. About 600,000 cu.yd. of stripping was required to expose the material. Aggregate is moved by carry-

ing scrapers from its original bank position to depressed grillages over the outer end of 36-in. belt conveyors. There are two of these primary belt-loading points in the gravel deposit, set in timber boxes, whose walls extend above the water table. Protection for the belt, entering on a 15 per cent grade, is provided by a 60-ft. length of salvaged tank-car barrel. The two 36-in. belts converge on a 42-in. inclined belt which carries the material to a raw storage area, from where it is reclaimed and carried over a 6-in. grillage which routes rejects to a crusher. All material then moves to a gravel plant centered around the delivery hoppers where classified material is carried by a belt to designated storage areas for transfer to the concrete plant. A feature of the storage in this plant is the use of waste material from the stripping or excavation operation to fill the dead storage area, thus avoiding waste of processed materials.

In the screening plant, material which goes through the smallest screen is fed to the first of four spiral classifiers where partial segregation is accomplished. Each classifier screw can be raised or lowered to permit carrying off more or less of the fines, which are thus released to the next stage, or in the case of final stage, to the waste pile. The first two classifiers discharge to a common belt; the other two each have a single belt. By means of variable speed belt drives, the proportions of these three sand grades are varied to obtain the blend that meets requirements; thereafter there is only one gradation of sand.

The main sand storage pile (live storage 6,000 tons) has a length of 180 ft. over which distribution is obtained by a shuttle conveyor on a structural steel frame. Drainage from sand in storage is provided by coarse rock trucked from the dam excavation and riprapped in the dead storage space, saving some 3,000 tons of blended sand that otherwise would have occupied the dead storage area. To insure easy escape of drainage water, timber culverts backfilled with coarse gravel were put on either side of the reclaiming tunnel, just below grade, discharging into a sump in the gravel pit. Gates admitting sand from the stockpiles to the belt in the reclaiming tunnel are on 7-ft. centers, and are so arranged that a drainage chute diverts seepage water

Fig. 2. Excavation at Friant Dam site; mixing plant and concrete placing equipment are being assembled in upper background.

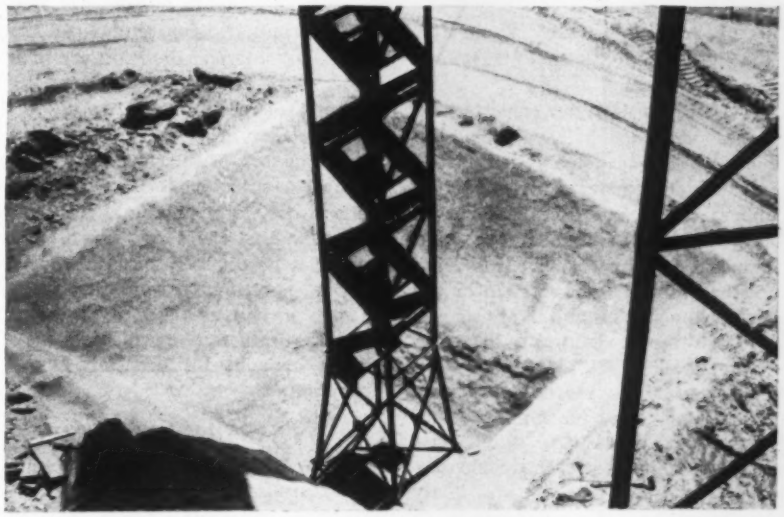


Fig. 3. In the stockpiles waste material was dumped (and slopes were riprapped around reclaiming tunnel gates) to occupy dead storage space.

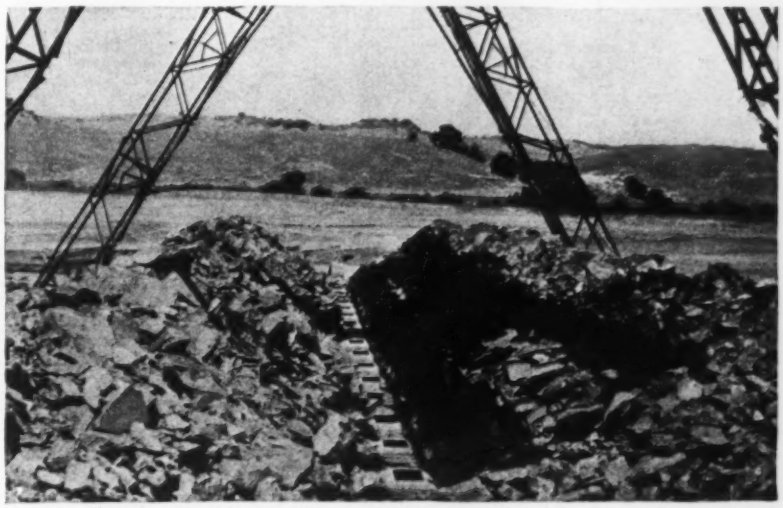


Fig. 4. Dead storage in the sand stockpile is filled in with coarse rock.

from the belt when the gates are closed.

The gravel is classified in four sizes, and a total of over 10,000 tons live storage is provided over gates in the reclaiming tunnel whose belt leads to the train loading hoppers.

New type belting

All conveyor belting, some 14,000 ft., is of a new cord design developed by the B. F. Goodrich Co. and used here for the first time on a large construction job. By applying the cord design used in tires to belting, several advantages over web-type belting are claimed: greater load carrying ability and impact resistance; less internal wear and abrasion; less stretch; and less deterioration. Splicing of the belt is done by a special field vulcanizing apparatus, which eliminates the metal fasteners ordinarily used.

The belt construction consists of a carcass composed of layers or plies of cord laid parallel and lengthwise and insulated from each other by rubber; a top and bottom cover of heavy rubber to take impact and wear and to protect the cords from moisture; and a breaker strip or ply between the carcass and the top cover in which the cords are laid transversely.

Aggregates are moved about two miles to the mixer plant in trains of seven 65-cu.yd. bottom dump cars with a 300-hp diesel-electric locomotive at each end of the train. Only one operator is required, however, as controls on the two locomotives are interconnected and both are operated from either cab. The operator goes from one locomotive to the other when the direction of travel is reversed, moving only for the sake of visibility. The controls from one cab to the other, which are carried through all car couplings, consist of eleven conductor cables and four compressed air lines, as well as the usual air line for brakes. As there is no occasion to take cars out of the train except for repairs, these connections do not have to be made often.

In addition to duplicate train and brake control, compressed air from the brake system is used to provide either cab with means for simultaneous opening and closing of bottom dump gates in all cars through a simple four-way valve. The aggregate train discharges into a seven-compartment track hopper, five for rock and two for sand, near the dam. Three cars of the train are provided with air jets (air from the stationary supply) for breaking up any tendency of sand to arch and thus interfere with free discharge. Hopper compartments are in the same order as at the gravel plant, spaced so that the seven cars of the train can be dumped simultaneously at one spotting. From the track hopper a belt delivers to bunkers over the mixers where there is a storage capacity for about six hours' operation.

Making and moving concrete

Bulk cement is brought to the site in boxcars from three mills, unloaded by pneumatic equipment, blended for color only, and stored in four 5,900-barrel silos. The 8-in. pipe from the silos to the mixing plant is 900 ft. long and lifts the cement 230 ft. Pumicite in the form of a powdery material weighing 40 to 47 lb. per cu.ft., with a specific gravity of 2.3 (98 per cent passing a No. 325 screen), is added to mass concrete in amounts equal to 20 per cent by weight of the cement used. This pumicite is trucked from a deposit three miles from the dam to a hopper near the mixing plant. A belt delivers it to a hopper over the batching plant where a separate control in the batch proportioning equipment puts the correct amount into each batch. Specifications call for concrete with a strength of not less than 3,000 lb. per sq.in. and 0.60 water-cement ratio. The cement content requirement varies from 0.8 to 1.5 bbl. per cu.yd. for different parts of the structure. Calculated proportions and weights of the typical batch of mass concrete are given in the accompanying table:

CALCULATED MASS CONCRETE PROPORTIONS PER CUBIC YARD

Sand... 945 lb. (0.33 cu.yd.) Total weight
Gravel. 2,640 lb. (0.94 cu.yd.) 3,585 lb.
Taking 3,585 lb. as 100 per cent, proportions are as follows:

Material	Weight percentage	Weight lb.	Volume cu. yd.
Sand	26	945	.330
¼ to ¾ in.	26	945	.338
¾ to 1½ in.	15	530	.189
1½ to 3 in.	18	635	.227
3 to 6 in.	15	530	.189
Totals	**100**	**3,585**	**1.273**

The mixing plant is on the left abutment at a level to discharge into cars at trestle deck level (El. 482). Four 4-cu.yd. mixers served by standard batching equipment mix concrete for 2½ min. Two used mixers put into this plant had their interiors rebuilt to conform to the modern design of three steel plates or vanes, set radially to the axis of rota-

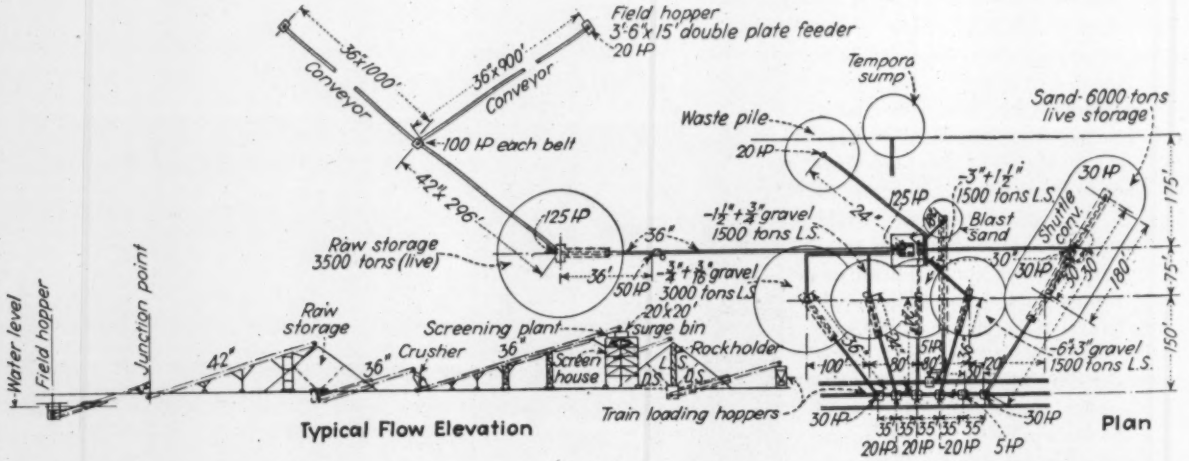


Fig. 5. Aggregate plant 2 miles from the dam will produce sand of four sizes, all combined in the stockpile, and gravel in four sizes. All belts converge to train loading hopper which has discharge gates arranged to load 7-car train at one time.

tion and attached to the mixer shell only along the edges. Instead of the design ordinarily used, the new plates were manganese steel made with outer edges of double thickness to increase the life where greatest wear occurs.

Diesel-electric locomotives handle the concrete cars, four 4-cu.yd. buckets per car. The construction program is based on sending all concrete out on this trestle and using its track exclusively for concrete trains. Form panels, supplies and other equipment come out on the service trestle (El. 355) on the downstream side, reached by the revolving derricks. By using two hammerhead cranes and two revolving derricks, each with track speeds of 125 fpm, the plan is to obtain the maximum rate of concrete placement with minimum interference incidental to handling forms, making cleanups, etc. A feature of the forms on this job is the use of an absorptive fiber mat or lining on all exposed surface form panels (experiments for this reported in *ENR*, Jan. 4, 1940, p. 40) to eliminate air bubbles and water holes and give a dense, smooth surface.

The "ice cream plant"

Because of the hot summer climate at Friant Dam and the contract requirement that concrete must not exceed temperatures of 70 deg. F. when placed, the contractor installed ice machines, popularly known on the job as "the ice cream plant," to prevent stoppage of concrete placing during hot weather. Based on the possible need for removing 11,780 Btu per cu.yd. of concrete, the refrigerating capacity provided equals a daily ice production of 353 tons. This is accomplished in two operations.

A plant consisting of a compressor equipped with double heads for use in the circulation of refrigerated water has a 238-ton capacity and a plant making ice crystals to go into the mixing water is rated at 115 tons of ice per day. In the latter machine frost is continuously scraped from the inner surface of a corrugated cylinder around which ammonia circulates at 9 deg. F. The output is water at 32 deg. F. containing as much as 50 per cent ice crystals. This product is pumped into the concrete batching plant.

Specifications require circulation of cooling water to begin immediately after pouring concrete. Cooling pipes are laid on the surface of each successive 5-ft. lift, spaced on centers that vary from 2½ to 5 ft. Assisting the cooling water, pumicite is believed to slow up the setting and thus to reduce the rate of heat generation of the concrete. The contractor is also using low-heat, slow-setting cement which has a setting heat about 10 deg. F. below that of ordinary cement.

Derricks for handling work

Special care was given to the selection of equipment for the high trestle. The two hammerheads and two revolving derricks chosen are believed to represent the maximum in efficiency for a trestle placement job. The hammerheads, each costing about $80,000, with d.c. equipment for accurate control and lifting speeds of 750 fpm, can each deliver about 180 cu.yd. per hour, and the required average of 125 cu.yd. should be an easy assignment. They will travel 125 fpm on 38-ft.-gage track and have an overall span of 314 ft. and a 72-ft. clearance under the arms.

Although they are expected to give material aid in placing concrete, the primary function of the revolving derricks is to do all the stripping and setting of forms, placing of valves, gates, handling reinforcing steel, grout pipe, etc. Such loads are picked up from the service trestle but have various destinations calling for facilities best provided by a revolving derrick. For this service a special design was made by the American Hoist and Derrick Co. The motor equipment totals 485 hp for each machine, and they have no brakes on the load drums, thus making it necessary to lower with power and obviating risk of dropping the boom. The load drums are powered for a pull of 17,000 lb. and a lifting speed of 325 fpm. These rigs have the same gage and travel speed as the hammerheads; they are 54 ft. from rail to boom pins; booms are 125 ft. long (will be extended to 150 ft.); individual motors drive each truck. They are expected to place a maximum of 140 cu.yd. of concrete per hour, 75 cu.yd. average, and cost $60,000 each with a.c. control.

Supplementing the hammerheads and revolving derricks, a pair of stiffleg derricks with 180-ft. boom (200-hp load and 75-hp swing motors) are provided, chiefly for handling concrete. They were assembled on the left bank, and as the job progresses will occupy the successive positions indicated in Fig. 6.

The high trestle was designed with the idea of removing deck panels and lowering concrete buckets through the deck when delivering to areas immediately below. For this purpose, the deck is divided longitudinally into three bays covered by 9x14-ft. deck panels which can be quickly lifted out by means of U-bolts. Heavy loads on this trestle require sizable steel sections. In the entire structure some 3,800 tons of structural steel is used. As an indication of size, some of the deck members are 36 in. W.F. beams weighing 194 lb. per foot; where the trestle

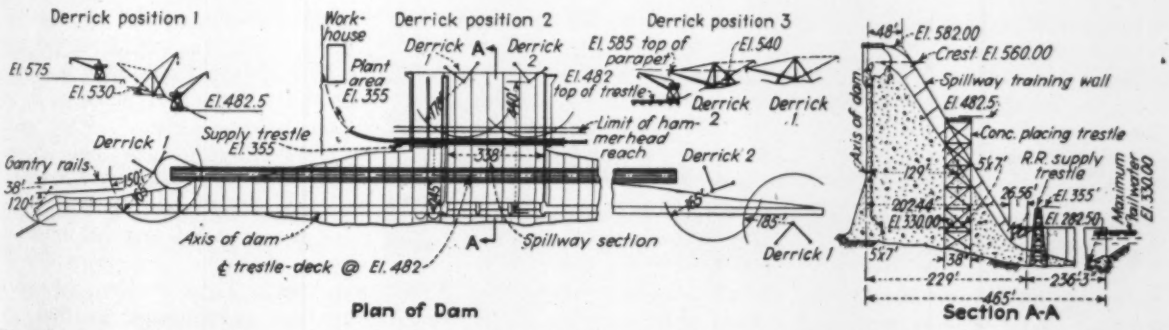


Fig. 6. Dam outline and concrete placing equipment. Hammerheads and revolving derricks operate on El. 482 trestle.

bents are 82 ft. apart, steel girders for this span are 8 ft. deep.

Instead of the combined air and water jets that have been widely used for surface cleanup, the program at Friant is to depend mainly upon sand blasting although some water is added at the nozzle. Later, a flushing operation sluices sand down a central drain in each block. About 0.06 cu.ft. of sand is estimated to be required per square foot of concrete to be cleaned or 14 cu.yd. of sand per 5-ft. lift of average area. Excess 3/16 to 1/4-in. material from the sand classifiers is used largely for this work. For blocks that can be reached by gravity from the high trestle, the sand is stored in tanks below the trestle deck, whence the air-ejector principle draws it out and delivers it to the nozzles through rubber hoses. From each sand service tank (which is moved up the bents as the concrete rises), pressure hose serves areas within a radius of 250 to 300 ft. For blocks outside these areas, there are semiportable sandblasting outfits on skids.

Removal of the material overlying bedrock at the site was done chiefly with power shovels loading dump trucks which carried it to spoil banks in the reservoir within the dead storage zone. Much of the overburden was loose material; blasting in the lower rock was limited to small powder charges to prevent injury to foundation rock. The lowest bedrock exposed is at El. 260 which makes the height of the dam 325 ft., as the top of the parapet is to be at El. 585.

For streamflow diversion a canal of 10,000-sec.-ft. capacity has been built on the left bank.

Personnel

The work is being done for the U. S. Bureau of Reclamation, S. O. Harper, Denver, chief engineer; Walker R. Young, supervising engineer, Central Valley project, Sacramento; R. B. Williams, project engineer at Friant, and J. H. Warner, resident engineer for Friant Dam. D. S. Walter is field engineer; E. S. Huntington, office engineer, and C. T. Douglass, concrete technician.

The contract is held by the Griffith Co. and Bent Co. operating under the general supervision of H. Stanley Bent as project manager, M. H. Slocum is general superintendent, E. L. Causey, engineer, and P. F. Schwartz, office manager.

Cement Does Not Cause Silicosis

Contents in Brief — The theory that cement dust causes silicosis was exploded by recent studies of 2,278 employees in the industry. X-ray examinations proved only eight out of the 2,278 showed evidence of nodular fibrosis attributable to dust, and it was found that chronic infections of the lungs in eleven cement plants averaged less than the rate of incidence in the general population.

A SILICOSIS STUDY of the employees of eleven cement plants is reported by the Saranac Laboratory for the Study of Tuberculosis in its 1939 report. The study was made by L. U. Gardner, T. M. Durkan, D. M. Brumfiel and H. L. Sampson of the laboratory, and was first published in the Journal of Industrial Hygiene and Toxicology, September, 1939. It shows that cement does not cause silicosis.

All of the 2,278 employees of the plants were examined by X-ray and their working histories were collected. Of the total number 299 were office workers or other people engaged in "non-dusty" occupations (control group), while 1979 worked in more or less dusty atmospheres (exposed group). The physical examinations showed little if any difference between the control group and the exposed group, although more than half the latter had worked in the cement industry ten years, nearly a third of them fifteen years, and eighteen for more than 45 years.

The survey showed that finished cement dust is often present in relatively high concentrations in the atmosphere of the finishing mills and packing departments, but this dust contains practically no free silica. In the raw mills and associated crusher houses the air contains a variable concentration of dust ranging from 1 to 30 per cent silica, and in a limited area in one plant, on occasion, as much as 60 per cent free silica, mixed with particles of limestone, shale clay, etc. In the quarries or mines, blasting and loading operations produce dust, which in occasional cases may be high in free silica. The hazard in quarries is generally slight, however, states the report, because natural ventilation is good and exposures intermittent.

Analysis of the pulmonary conditions shown by the X-ray photographs indicated that prolonged inhalation of dust from finished cement produces such slight anatomic reactions that little or no abnormality is seen in the roentgenogram. On the other hand, the mixed dusts of the raw mills, which contain free silica in varying amounts, are probably responsible for a limited number of cases of well marked linear exaggeration of the lung passages, which is not a symptom of silicosis but in part a natural accompaniment of age and in part a resultant of exposure to non-toxic dust. Only two individuals (exposed to sandstone dust in special operations) showed nodulation resulting from their cement industry employment.

When compared with the dust hazards in hard rock mining and other silica industries, the report concludes, the problem in the cement industry is trivial; only eight of the 2,278 employees showed evidence of nodular fibrosis attributable to dust, and in six of these an exposure to silica dust in previous employment was presumably responsible for the formation of silicosis nodules. Further, the incidence of tuberculosis and other chronic infections of the lungs were found to be less than that in the general population.

Earlier studies of the relation of cement to silicosis were reported by the U. S. Public Health Service (Bulletin 176, "Health of Workers in a Portland Cement Plant," 1928) and by the Portland Cement Association (1938). The former covered 570 men, the latter 14,148 men, and in both cases it was stated that no unusual amount of chronic respiratory illness was found. These studies, however, were not as thorough as that at Saranac.

Electrically Heated Asphalt Plant

ROBERT JOHNSON

Consolidated Edison Co., New York, N. Y.

Contents in Brief — The largest electric-heating installation yet made in an asphalt paving plant. Using 510 kw in heating elements, this plant produces 100 tons of paving mix per hour. All heating of materials except the limestone and sand, which are heated in an oil-fired kiln, is by electricity.

ELECTRIC HEATING marks an important advance in the new hot-mix asphalt paving plant constructed for the Del Balso Construction Corp., The Bronx, New York City. This plant has a capacity of 100 tons of paving mix per hour. All heating of materials except the limestone and sand, which are heated in an oil-fired kiln, is by electricity, using 510 kw in heating elements. This is the largest electric-heating installation yet made in an asphalt paving plant. Another plant in Newark, N. J., operated by the Franklin Construction Co., was described in *Engineering News-Record*, Aug. 3, 1939, p. 162.

The Bronx plant consists of four storage tanks each 10 ft. in diameter and 40 ft. long having a capacity of 25,000 gal. each; two superheaters of 4,500 gal. each; two weighing buckets, and two mixers of one and two-ton capacity. The asphalt is shipped in barges; heated to a liquid state when pumped into the barge, it retains sufficient heat at the delivery point to be pumped from the barge into the storage tanks.

In the storage tanks, the temperature is raised and maintained at 225 deg. F. by eighteen heating units. Each unit consists of a steel tube 10 ft. long, sealed at one end, and a 3-kw open-coil heating element. Each unit can be individually inspected or replaced in case of a burn-out; also each unit is individually controlled by a switch permitting flexible operation, as only the actual number of units required to maintain the desired temperature need be connected to the service. The temperature of the asphalt is controlled by a gas-filled thermostatic bulb actuating an indicating thermometer controller. The bulb is enclosed in a well socket built into the wall of the tank. In addition to the immersion units, 3 kw in Calrod units are attached to the lower half of the end of each tank opposite the main heating units to compensate for radiation losses on the unheated end. The tanks are covered with 3 in. of 85 per cent magnesia and waterproof covering.

Twenty-four 3-kw heating units are installed in each of two superheaters which are located directly beneath and piped to the storage tanks. These units raise and maintain the temperature of the asphalt at 300 deg. F., are of the same type as the units installed in the storage tanks, and are controlled electrically and thermostatically by the same type of equipment.

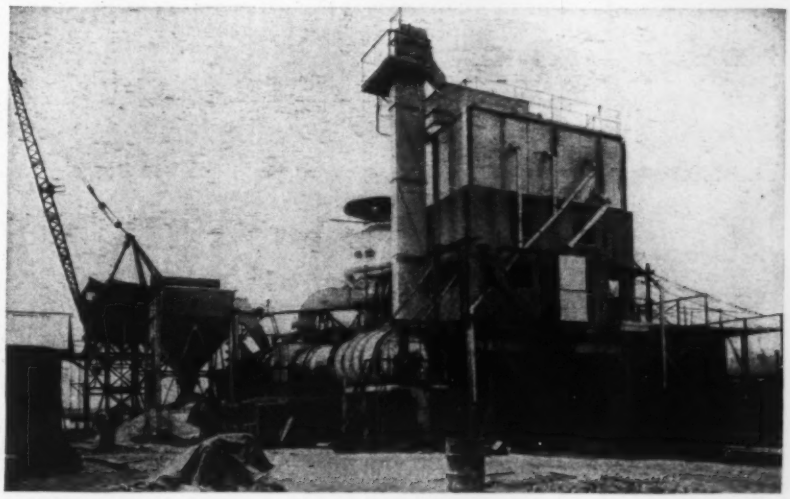
Overhead pipelines connect the superheaters with the weighing buckets located on the mixing platform; 60 kw in Calrod units, thermostatically controlled, are uniformly spaced around the pipelines. The bulbs of the thermostats are installed flush against the pipes to compensate for radiation losses and to maintain the temperature of the asphalt flowing through the pipes at 300 deg. F. Aluminum sheets are installed over the pipes and heating units to reflect the heat to the pipes. Insulation and weatherproof covering are installed over the aluminum sheets.

Each weighing bucket is equipped with 5 kw in Calrod units that are insulated and attached to the lower outer sides of the bucket. The heaters are controlled by a thermostat to maintain the temperature of the asphalt at 300 deg. F.

The limestone and sand to be mixed with the asphalt are heated to 500 deg. F. in an oil-fired kiln, and are then loaded into a bucket elevator and deposited on separators for grading to size. From here the mixture passes through the hopper and into the mixer where it is combined with the hot asphalt from the weighing bucket. The mixers are each equipped with 12 kw in Calrod units which are installed similar to those on the bucket.

The dryer is equipped with low pressure electric actuated oil burning equipment. No. 6 fuel oil is preheated to 175 deg. F. by a 39-kw fuel oil preheater prior to entering the combustion chamber.

A schedule of operation is being prepared whereby all of the asphalt in storage tanks and superheaters will be heated during the night to a predetermined temperature, thereby preventing the heating demands from coinciding with the normal plant operation demands. This method of operation will produce a better load factor and effect considerable economies in plant operation and electric heating costs.



General Electric Photo

Asphalt plant turns out 100 tons per hour of electrically heated paving mixture.

Houses Built to Last 60 Years

***Contents in Brief**—The Carmelitos housing project in North Long Beach, Calif., will provide 607 family dwelling units, averaging 4½ rooms. Designs and choice of materials were based on a 60-year life expectancy. Quantity production effects large economies, precast floor joists and a new type of "wrinkled" metal floor forms being used.*

A 50-ACRE TRACT in the northern outskirts of Long Beach, Calif., is the site of the Carmelitos housing project, now well under way, which is estimated to cost $2,300,000. The 88 one and two-story structures to be built on the tract will include a total of 607 family dwelling units, and for each of these the county is to eliminate one sub-standard dwelling.

The financial program on this project is set up on the basis of a 3 per cent annual retirement subsidy being advanced by the U. S. Housing Authority, based on the expectancy that the buildings will have a 60-year revenue life. This 60-year life requirement was a governing factor in making decision on design, materials, and construction methods. Construction was begun last September.

Because of the size of the undertaking, it was possible to arrange quantity production so effectively in all parts of the operation that despite variety and individuality for each type of unit, a total construction cost was worked out which is little if any in excess of the cost for ordinary wood frame dwellings. All the structures have concrete walls and floors, tile roofs (clay shingles), copper water pipes, and roof trusses made of chemically treated timber put together with bolts. Other than these trusses, very little wood is used in the buildings. This is chiefly for nailing strips in second-floor ceilings.

New methods and materials

A quantity production feature that is important in keeping costs down is a steel wall form with specials for window and door openings, permitting the greater part of the framing work usually required around openings to be provided for in the initial pour. All floor joists, window sills and stairs are precast concrete made at a conveniently located plant and delivered to the job ready for assembly. A new idea in metal forms for floor slabs saves cost and simplifies floor construction. Reinforcing for beams and wall panels comes to the job in pre-assembled, welded-up units ready to be set in place bodily. The use of steel forms and thorough vibration results in exceptionally smooth finishes and, by avoiding joints in wall forms at wall intersections, particularly good results are obtained in the concrete finish at the corners of buildings.

Steel form panels for the walls are numbered and, although built to be interchangeable, it has been found best to put them in the same relative position in each successive assembly. Thus when a panel edge has been adapted to a close fit with the one

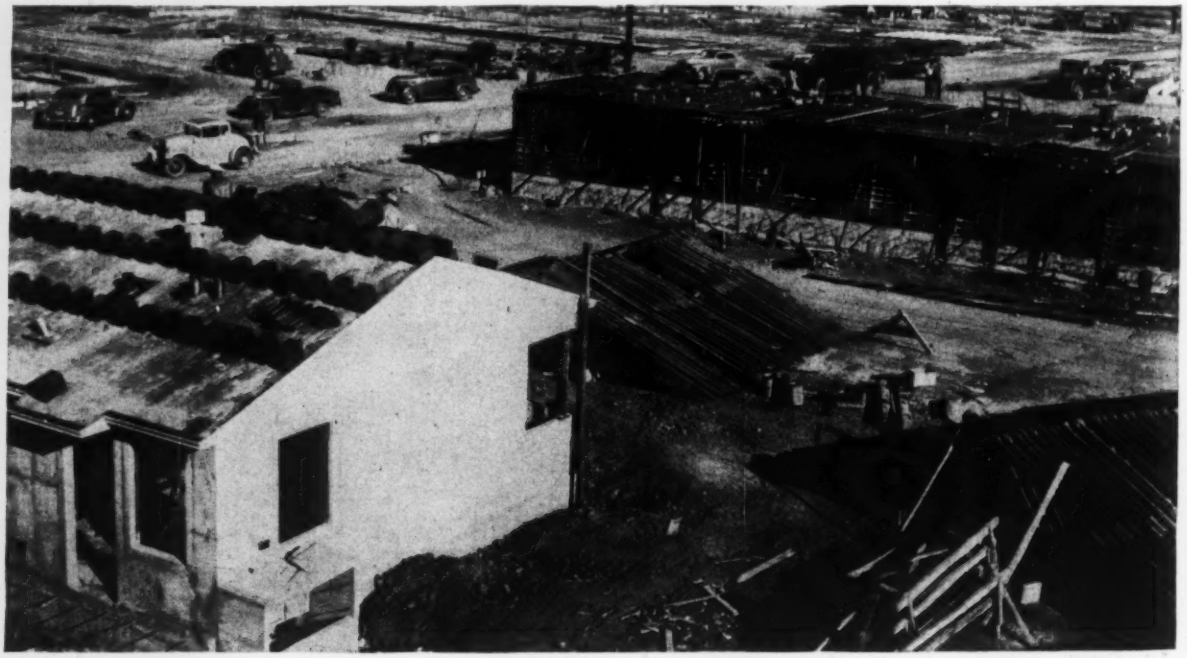


Fig. 1. Concrete walls, precast floor joists and slabs, timber roof trusses and clay shingles are features of Carmelitos houses.

adjoining, this same good fit is repeated as long and as often as the forms are used.

The first floor construction was studied carefully before a design was selected. The primary requirements were a dry floor, a durable sanitary finish with low first cost and low upkeep. The design adopted includes precast concrete joists on which the floor slab is poured in place. A major feature of floor construction is the form used beneath the floor slab which consists of corrugated or "wrinkled" panels made of 26-gage metal. As these panels are left in, it is not necessary to provide clearance below the joists for crawl space. Had wood forms been used, their removal would have been desirable because of termite activity. Only concrete or metal was put below the first floor level because of the termite menace. To keep water away from the foundations a 4-ft. concrete walk extends entirely around each building, poured directly against the building walls.

Foundation excavations

Foundation excavations are made by a ditching machine that cuts 18 to 24 in. wide. After the concrete foundations are poured, using ready-mixed concrete, the precast floor joists are set in place. The joists have shoulders, cast for this purpose, to support the "wrinkled" forms for the floor slabs. These forms are strong enough to support the weight of workmen placing the grillage of steel bars laid atop the metal forms as reinforcing for the floor slab. The steel is supported at the desired level by stirrups which project along the tops of the joists. These bars in the joists also provide bond between slab and joist when the floor is poured. Floor slabs are 2½ in. thick and have a maximum span of 2 ft.

Steel forms for the first story walls, which are 6 in. thick, are fastened to foundation concrete by bolts, left projecting for this purpose, and are trued and held with the aid of temporary wood braces. The second floor is of slab construction for which forms are supported on timber posts.

Reinforcing steel is kept in the center of the walls. This is because both faces are left exposed (after being finished with concrete paint) and because thorough tamping and vibration are desired near the faces, free from interference by reinforcing

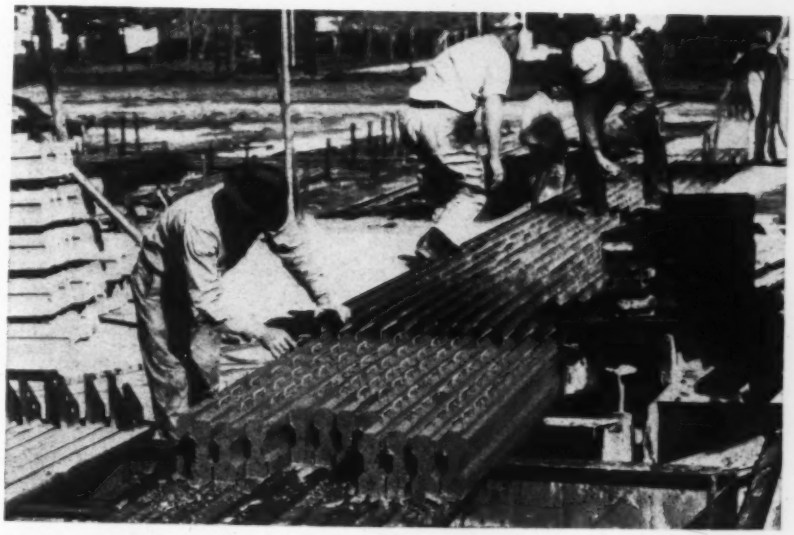


Fig. 2. Precast concrete joists being extruded from forms mounted on vibrating platform. When free of forms, the racks are rolled forward under a spray for moist-curing. Upright ends on empty racks at left indicate how extrusion is effected.

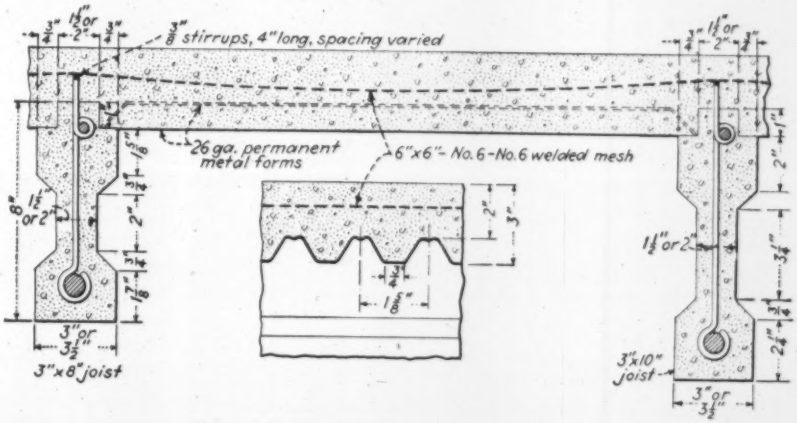


Fig. 3. Section showing detail of construction of precast floor joist and floor slab.

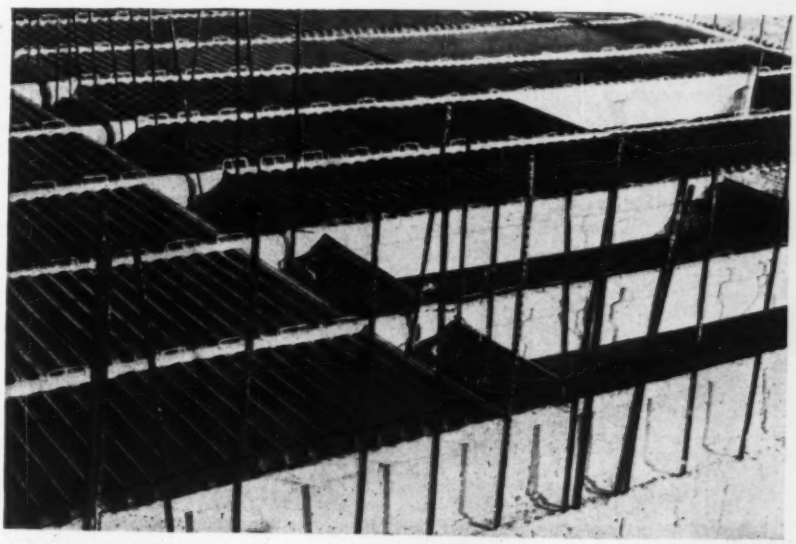


Fig. 4. Forms for the floor slab are made of "wrinkled" 26-gage metal. They rest on shoulders cast in the concrete joists. Note stirrup rods projecting from joists which serve to support reinforcing of floor slab.

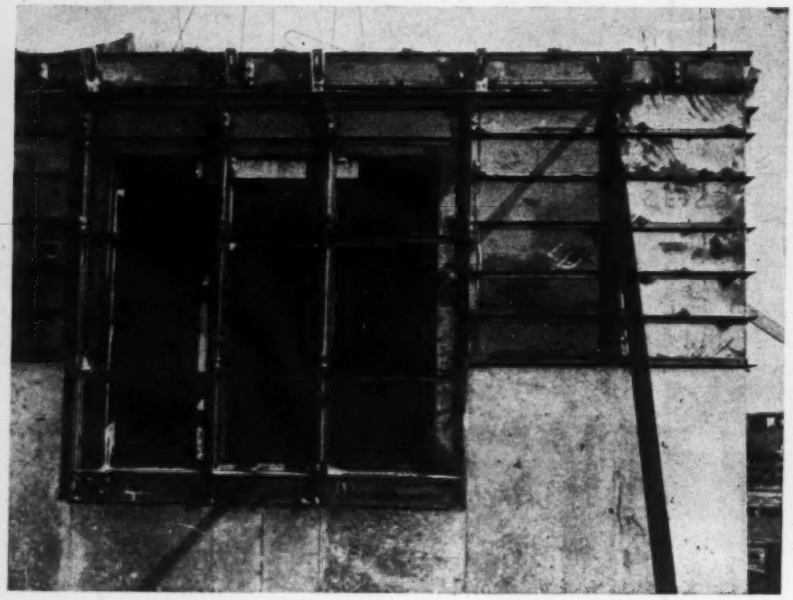


Fig. 6. Steel wall forms are used exclusively; initial pours complete window openings except for the precast sill, which is added later.

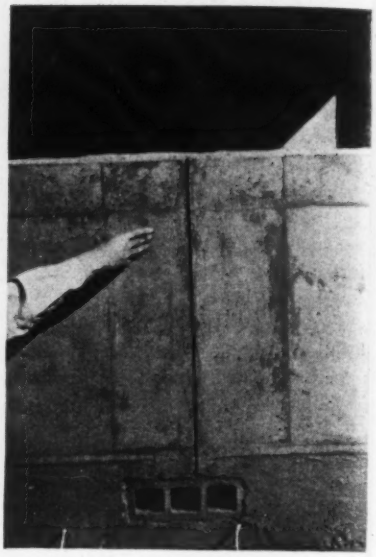


Fig. 7. Dummy joints directly under center of windows avoid risk of unsightly cracks.

steel. All wall forms are steel, but the forms used on the underside of the second story floors are 4x8-ft. plywood panels. The standard interior wall thickness was made 6 in. to give resistance to horizontal forces amounting to 8 per cent of gravity. A few 4-in. walls are used for closets.

To avoid unsightly shrinkage cracks in two-story walls, dummy joints are used, centered above and below window openings. These are formed by 3/16-in. strips of 22-gage metal fastened to the forms and removed with them. Thus, with 1-in. projections of the strips into inner and outer faces, the 6-in. normal wall thickness is here reduced to 4 in.

The job engineer and the contractor for precast joists developed technique of manufacture such that joists satisfactory to all concerned are being turned out at a cost less than the estimate. The construction plan includes vibrating platforms and multiple steel forms from which the cast joists are extruded. Joists are delivered and installed by the manufacturer.

Concrete in these precast joists is required to have a strength of 3,000 lb. per sq. in. in three days; not only is this always met, but strengths as high as 5,000 lb. in three days have been recorded. The concrete is put into the forms very dry; the joists are extruded almost immediately and are at once coated with a sealing compound to prevent evaporation.

Concrete stairways

Similar economies were also developed for the concrete stairs which are made by assembly of stringers and a tread-and-riser combination, both precast. With vibrated steel forms, it is believed that smoother, straighter finishes are obtained on protruding nosings than would have been possible in monolithic construction. The precast concrete stringers are first bolted to the concrete frame of the building and then the tread-riser combinations are grouted into the grooves especially provided for them.

Two grades of concrete are used. All concrete below the first floor level is made up in 4-cu. yd. batches of the following proportions: 2,068 lb. of cement; 5,600 lb. well graded sand; 2,872 lb. of 1½-in. rock; 3,900 lb. 1-in. rock; 958 lb. pea gravel.

Because smaller rock is desirable for the walls, where very thorough tamping and vibration are required, the mix for the 4-cu. yd. batches above floor level is as follows: 2,068 lb. cement; 5,800 lb. sand; 5,730 lb. ¾-in. rock; 1,500 lb. pea gravel.

With these mixes, enough water is used to give a 4 or 4½-in. slump, the concrete weighs 151 lb. per cu. ft. and strength in 7 days averages 2,200 to 2,500 lb. per sq. in.; in 28 days, 3,500 to 4,000 lb. per sq. in.

Timber for roof trusses is treated with a chemical compound, and in the truss assembly important joints are bolted. The trusses are assembled on a templet using members previously cut and bored in quantities. A crew of two men (with a third aiding in stacking the trusses as they are completed) bolts up about 40 trusses per 8 hr. All openings into the space under the roofs are screened, and regular inspections of this space are made to detect signs of termites.

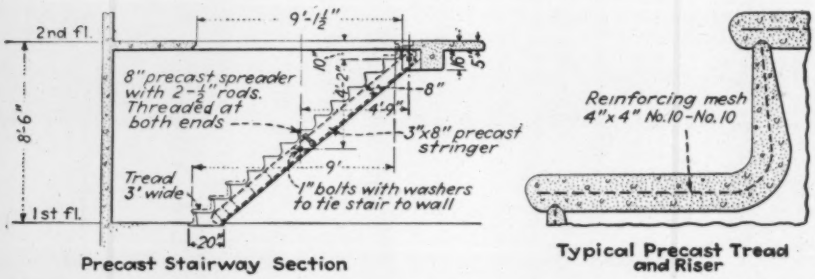


Fig. 5. Details of precast concrete stringer, tread and riser for stairways.

Utility lines for each building, (sewer connection, water and gas pipes and electric conduits), are put in a manway trench excavated 3½ ft. below joist level on the side of the building where kitchen and bath are located. All water pipes other than the large cast iron supply mains are copper, including the 2-in. service connections to the cast iron lines. Interior and exterior concrete surfaces are finished with a paint especially prepared for this job including cement, silica, calcium stearate, calcium chloride and pigment, the last named in quantity not exceeding 6 per cent of the weight of cement used. The ingredients are mixed with water for application.

Rental cost

Although the rates of rental for the family units have not been settled as this article is written, the average rate, including utilities, will be well within the amount that can be afforded by the "lower third" of the people. Utilities will include water, electricity and gas for refrigeration and cooking as well as for space heating in one room. Despite the flat rate, all utilities to each family unit are metered, and meters will be read periodically as a means of checking waste. The household equipment will include electric refrigerator, gas range, hot water heater and floor-type gas furnace in one room. Community landscape care will be included in the rental but care of the grounds at front and rear of each house will be left to the householder.

Personnel

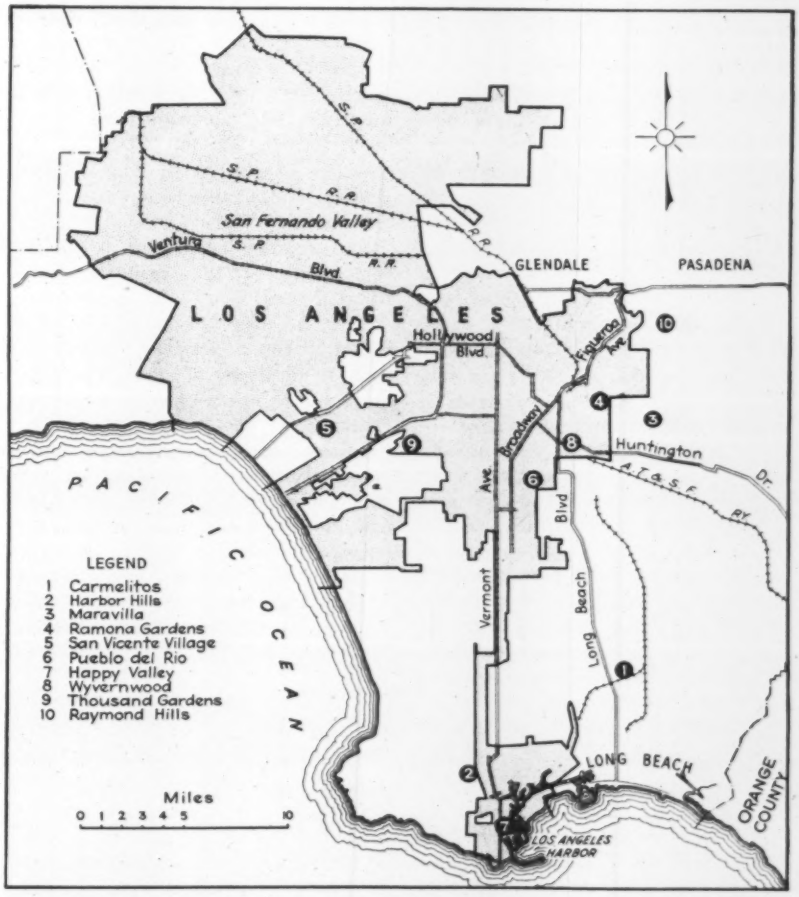
The plans were drawn and construction is being supervised by the Associated Housing Architects consisting of Cecil A. Schilling and Kenneth S. Wing, architects and C. Arthur Schilling, engineer; Clarence S. Stein, consultant. The general contract on the job is held by the George A. Fuller Co. Contract for the precast floor joists, "wrinkled" forms, floor slabs, stairs and window sills is held by the Fabriform Co. under the direction of Fred Bagaman. General construction is under supervision of the Los Angeles County Housing Authority; Melville Dozier, executive director, and John Stearns, assistant executive director. J. H. Davies is structural engineer on the Carmelitos project.

Mass Housing at Los Angeles

Contents in Brief—Rapid population growth and increased demand for rentable dwellings have given great impetus to mass housing projects in Southern California. Such undertakings definitely planned or already under construction by Los Angeles city and county housing authorities comprise 2,917 family units. Others are being built by private interests.

OF THE NUMEROUS mass housing projects now under way in western states, particularly notable are those in southern California where there was early organization of housing authorities by the city of Los Angeles, and also by the county, to take advantage of federal funds available through the U. S. Housing Authority. Among the county undertakings, the Carmelitos housing project, described in the preceding article, is notable for the 60-yr. life expected of the 607 family dwelling units it includes. In striking contrast with this are the portable camps for migratory workers, designed and built in rural districts by the Farm Security Administration for very short periods of occupancy. Between these two extremes are mass housing ventures of many kinds, some public and some private.

A major stimulus, of course, has



Map showing locations of ten mass housing projects in and near Los Angeles.

TABLE I — PUBLIC HOUSING PROJECTS AT LOS ANGELES, CALIF.

	Los Angeles County Housing Authority			Los Angeles City Housing Authority			
Name of project	Carmelitos	Harbor Hills	Maravilla	Ramona Gardens	San Vicente Village Near Pico and Sepulveda	Pueblo del Rio Near 51st and Central Ave.	Rancho San Pedro
Location	N. Long Beach	San Pedro	Belvedere				Happy Valley
Number on map	1	2	3	4	5	6	7
Starting date	Sept. 1, 1939	Feb. 6, 1940	June 1940	March 1, 1940			
Completion date	Dec. 1, 1940	Jan. 10, 1941	July 1941	March 15, 1941			
Total development Cost (estimated)	$2,300,000	$1,300,000	$2,000,000	$2,771,000	$846,000	$1,780,000	$1,302,000
Basis of U. S. H. A. loan contract†	2,331,000	1,173,000	2,178,000	2,493,000	761,000	1,602,000	1,171,000
Land costs	60,000	15,000*	325,000	76,619	37,222	184,000	89,73[illegible]
Building costs‡	2,240,000	1,285,000	1,675,000	1,336,913	515,600	1,030,800	762,20[illegible]
Building and equipment cost per unit	2,600	2,750	2,670	2,191	2,578	2,562	2,57[illegible]
Total acreage	50	30	55	32	9	21	1[illegible]
Number of buildings	88	52	105	102	25	64	4[illegible]
Number of family dwelling units	607	300	504	610	200	400	20[illegible]
Family units per acre	12	10	9	19	22.2	19	22.7
Total number of rooms	2,644	1,342	2,238	2,684	800	1,840	1,18[illegible]
Average number rooms per unit	4.4	4.5	4.4	4.4	4	4.6	[illegible]
Number of houses to be cleared	None	None	250		33	182	6[illegible]
Type floor construction	Reinforced concrete	Reinforced concrete	Reinforced concrete				
Type wall construction	Reinforced concrete	Reinforced brick	Concrete block	Reinforced brick	Reinforced concrete	Reinforced concrete	Reinforced concrete or brick
Type roof construction	Wood, chemically treated		Wood, on treated plates				
Roofing	Flat tile	Concrete Tar & gravel on felt	Flat tile				

* Property donated, cost represents demolition and clearing expenses.
† These loans never exceed development cost; are revised as actual costs accumulate.
‡ Includes utilities, landscaping, engineering, administrative, carrying charges, etc., with 5 per cent for contingencies.
Figures on work not started before March 1, 1940 are estimates; others are based on contract awards.

been the $800,000,000 mass housing program (for the country as a whole) initiated by the USHA. This organization, in contrast with mass housing projects undertaken by the PWA, has announced the objective of decentralizing control and putting local officials in full charge of selecting sites, establishing rates of rental and deciding upon facilities best suited to the location. Earlier endeavors of the PWA put standards too high and hence did not relieve the slum conditions for which remedy was intended. Under the Wagner-Steagall Act, and as the USHA is now set up, one sub-standard family unit is to be eliminated for each new dwelling unit constructed.

Under this program the housing projects are tax-exempt properties and there are some operation costs that have to be met by the county or the city where a county or city organization is the controlling body. The loss of tax revenue and the expense items are more than offset, it is said, so far as the burden on the taxpayer is concerned, by savings in other directions. For example, better housing facilities are expected to decrease crime, because 60 per cent of crime is fostered in slum areas; decrease epidemics, and decrease juvenile delinquencies, which develop largely in slum areas. All these decreases are credited as savings in city or county operating expenses.

As in Great Britain, the policy here has been to require tenants to meet certain standards. In order to qualify, applicants must be citizens of the United States with an annual family income of not more than $1,000 but sufficient to justify paying the rentals asked.

USHA funds are available to state, county or city organizations that qualify. Such organizations have been formed by the City of Los Angeles as well as by Los Angeles County, and a bill which would have set up a California State Housing Authority was introduced at the recent session of the legislature but was defeated.

The housing authority of the County of Los Angeles, typical of what is necessary to meet USHA requirements, operates under a state enabling act passed in 1938. Under provisions there set forth, the executive body is a commission of five members appointed by the governing body of the county and responsible only to that body (in this case the board of supervisors). The function of the commission is to comply with all requirements for obtaining USHA funds and to plan for expenditures that exactly fit local needs in the different parts of the communities to be served. Thus far the Los Angeles county housing authority has had allocated to it about $6,500,000 in federal funds, and more is expected as the work of planning additional projects advances.

Rentals on USHA projects are to go entirely into operation, including utilities, upkeep, interest and repairs. An amount roughly equal to that paid by the tenant is paid by the USHA for interest and amortization of bonded indebtedness. In the privately financed mass housing projects, higher standards usually are set. In the Los Angeles area, minimum private project rentals are about $35 per month per family unit.

In Table I are grouped data on mass housing facilities recently started or projected by housing authorities now functioning for the city and the county. Private projects are on quite a different footing as they are not slum clearance undertakings. General data on three private projects in southern California are given in Table II.

TABLE II — GENERAL DATA ON THREE PRIVATELY INITIATED HOUSING PROJECTS IN SOUTHERN CALIFORNIA

Name of Project	Wyvernwood	Thousand Gardens	Raymond Hills
Number on map	8	9	10
Starting date	January 1939	June 1940	April 1940
Completion date	January 1940	June 1941	January 1941
Total development cost	$6,000,000	$7,000,000*	$900,000*
Area included, acres	72	110	15
Number of structures	143	97	28
Number of dwelling units	1,102	663	200

* Estimated.

Construction Contracts for Defense

LOUIS B. WEHLE
of the New York Bar

***Contents in Brief**—For speed and efficiency, a great program of emergency defense construction requires forms of contract different from those of peacetime construction. Experience with World War emergency contracts when applied to 1940 conditions indicates that fixed-fee contracts are satisfactory only for work fully planned in advance. A special form of contract is necessary for unplanned emergency work. On the basis of experience and analysis the author proposes a percentage fee contract, safeguarded by special provisions, as best.*

A GIGANTIC PROGRAM of emergency construction will soon take form in Washington. In addition to the enormous aggregate of shipyards and industrial plants and other structures capable of initial specification, we know that the program will call for public works of perhaps still greater volume that cannot be planned and specified in advance, such as protected seaplane bases, armored hangars and other military airport facilities, storage warehouses, coast defenses, strategic highways and tunnels and training camps.

I. Vital objectives

That program will call for the utmost attainable speed and efficiency, with due regard for fairness to the contractor and economy for the government. In attaining these four objectives much will depend upon the principles on which the contracts are drafted. They should be so designed as to enlist the highest available engineering and organizing ability at the top of each contract, the best and most responsible technical craftsmanship for the subcontracts, and a smooth, swift, fair governmental procedure of supervision and adjustment to expedite the handling of every unforeseeable circumstance.

What are the types of contract that are apt to be used by the government in these emergency construction contracts? As background we can examine some types of war emergency contracts of 1917-18 and inquire to what extent the principles of those earlier contracts could be used to meet today's requirements. In this connection we shall come to compare existing conditions with those of 1917. Perhaps the essential principles of contract policy that should be embodied in today's emergency contracts will then stand out.

In 1917 Mr. Wehle, as one of counsel to the General Munitions Board—later the War Industries Board—drafted the form of the Army's cost-plus-percentage contract. During the same year he served as special assistant to the Secretary of War, and there dealt with administration of that contract. In 1918 he was counsel to the U. S. Shipping Board Emergency Fleet Corporation, and negotiated and drafted contracts for construction of shipyards, ships and ship-workers' villages. This work, together with his later service as general counsel of the War Finance Corporation and extensive subsequent experience with construction contracts, qualifies him to speak with the authority of detailed knowledge on the difficult problem of contract forms for defense work.—EDITOR.

II. Conditions in 1917 and 1940

Let us compare at a few points the present and former conditions for their bearing upon the emergency construction program.

1. In 1917 there had been three years of European war and we had at hand established war techniques to which we could gear our training and production program. The purpose was to carry on essentially offensive military and naval operations in Europe. Air warfare still played a minor part.

Today we are preparing for a vast home defense on sea, along shore and on land against new and as yet ungaged methods of offense, with air warfare in perhaps a major role. Thus the volume of public works is apt to be far greater than in 1917. And because defense strategy is still in process of evolution against novel methods of offense, much of that public work may have to be begun by the contractor with only a bare outline of his prospective task.

2. Our 1917-18 emergency construction was done under pressure of actual war; today we are still nominally at peace. Yet at the moment this distinction seems not very significant, because the construction task today promises to be so much greater in extent than that of 1917 and to call for so much more of defensive materials, requiring greater time for fabrication and installation.

3. In the twenty years before 1917 the American construction industry had seen a steady expansion, and there were in existence a far larger number of financially strong, well-organized contractors than today. The change presents a real difficulty. Policies in making and administering contracts should therefore be directed toward enlisting as associate contractors or as subcontractors the many reserves of construction specialists who today are out of business or have survived the years since 1930 with shrunken resources. This will call for industrial statesmanship in designing the contracts and subcontracts.

4. Not all comparisons with 1917 indicate a present disadvantage. Thus, we must inevitably profit at the outset from our 1917 experience in mobilizing materials, labor and transport. Again, during the past fifteen years government agencies have acquired much detailed knowledge and

management experience, which will facilitate the handling of supply and priority problems.

In 1917-18 under some contracts the government procured all materials and furnished them to the contractor. Its ability to do this efficiently seems to be far greater now than in 1917, which suggests that we can avoid inflation in materials prices. Wages today are on a higher level than in 1917 in relation to the cost of living and to compensation in other occupations, so that there would be less of merit in pressure for sudden wage increases; and governmental administrative machinery is more readily available for checking unreasonable wage advances. Also, we could in this emergency avoid a repetition of 1917's vast confusion and waste in connection with labor costs due to the contractors' mad competition for labor, if the government would be responsible for allocating labor among the various contractors and would incidentally regulate wage adjustments from the outset.

III. 1917-18 construction contracts

1. *The Army's emergency construction contract.* Immediately after approval on May 19, 1917, of the Draft Act, we had to provide for training and embarkation of an expeditionary force. Less than three months later the National Army cantonments were housing 287,308 men, and before the end of the year fully 1,400,000 men were being housed and served. The cost of new camp construction estimated by the War Department as of Jan. 1, 1918, was about $198,000,000. By February further construction work in process and in prospect for the Army alone amounted to $420,000,000.

This work for the Army was done under the "Emergency Construction Contract." The contractor was reimbursed for defined costs. His fee (to cover all general overhead expense except as specifically provided) was a sliding-scale percentage of cost but was limited to a maximum of $250,000 no matter how great the cost. The sixteen cantonments as reported on Jan. 1, 1918, cost about $140,700,000 (an average of over $8,000,000 per job); the general contractors' fees aggregated $4,000,000, or 2.84 per cent. On all the new camp construction ($198,000,000) the general contractors' fees averaged 3.76 per cent.

Clearly as to speed, and in the main as to efficiency and fairness, the Army's percentage contract was a significant success. But as to economy this must be said: The form of the contract, designed for use in all contracts, was used also in smaller contracts — hospitals, ordnance depots, storage structures, etc. It provided a sliding scale of fees: from 10 per cent if the cost were $100,000 or less, down to 6 per cent if $3,500,000 or more (but subject to the $250,000 maximum fee). This form of contract met with much harsh criticism and public misunderstanding as allowing the contractors a 10 per cent fee on these enormously costly public works. Also, at many points there developed slackness, inefficiency and waste.

The public believed that the contractor easily acquiesced in or encouraged enhancement in prices and wages to increase his fee. This motivation seems doubtful in the cases of the major contracts, where the maximum fee limitation operated; but it must be said that it could well have been present in many smaller jobs. Injury to the public interest from this source could have been averted, in this way:

In the typical war emergency construction situation, the contractor is put to work at a time when the government has no idea of the scope of the work, and a fixed fee is an impossibility, since there is nothing on which the minds can meet. The only available criterion for compensation is some automatic one which moves along with the volume of the work. And the natural measure of volume of the work is its cost. Now, costs are a fair enough measure of volume when the contractor (as was the case in June, 1917) is financing those costs from his own resources or credit—advancing money for payrolls and for materials. Then as prices and wages go up, there is an increased burden on the contractor for which he should be compensated by a percentage on that increase. But what if the costs are financed by the government, as came to be largely the case after about July, 1917, when the government's accounting work had become organized? What if the government makes such advances to the contractor as enable him to finance all job costs without resorting to his own pocket? Then a device which compensates the contractor by a percentage on price and wage increases has become doubly unsound. It not only tends to render the contractor passive as to price and wage increases; but it also gives him taxpayers' money for nothing.

There is a simple way out of this dilemma. Although suggested by the writer in the late summer of 1917, it was never put into force. It seems to be worth bearing in mind, for it would enable the parties on a "blind" job to measure the fee in terms of volume without incurring either of these difficulties. The parties can use two classes of costs; they can use actual costs when reimbursing the contractor for outlays, but when computing the fee they can employ fixed unit prices of materials and fixed wage scales set forth in schedules attached to the contract. The 1917 cost-plus-percentage contract might have avoided much of its odium if it had contained this feature. For the same reason, this form of safeguarded contract could be satisfactorily employed in the present emergency.

2. *Navy contracts.* The Navy quickly took advantage of the March 4, 1917, act which enabled it to transform existing lump-sum contracts into percentage contracts. Thereafter, in 1917-18 a typical form of a ship construction contract called for reimbursement of actual costs plus a "fixed profit" equal to 9 per cent of the estimated cost, plus a bonus equal to 50 per cent of savings on the estimated cost.

Expenditures of the Bureau of Yards and Docks for public work during the World War period were about $60,000,000. Beginning early in 1917 and thereafter, under its June 7, 1917, circular, its fee to a contractor was 10 per cent if he did the work and 5 per cent if a subcontractor did it. These contracts were executed at high speed and efficiency and their administration was never seriously criticized from any quarter. As their volume was only about one-tenth that of the Army's emergency construction program, the principles of the contract were subjected to less of a strain.

3. *Shipping Board contracts.* As of Oct. 15, 1918, the United States Shipping Board Emergency Fleet Corporation had expended on land or shore construction work about $76,000,000 on new shipyards or expansion of old ones; and about

$59,000,000 on housing for shipyard workers. Over $600,000,000 had been expended for building new ships, and over $300,000,000 for finishing ships requisitioned while under construction. All of these classes of work were initially definitized as to volume and scope and traditionally would have called for fixed compensation to the contractor.

The shipyard construction was largely done in the earlier period under so-called "lump sum" arrangements embodied in the ship construction contracts, but a peculiarity of these contracts was that schedules of materials, prices and wages and salaries were attached, and the "lump sum" was either expressly or impliedly to be increased when these schedules were exceeded. In other words, "lump sum" was a misnomer. In 1918 to an increasing extent the combined contracts for ships and for yards came to be upon the basis of cost plus fixed fee. The two contracts of September, 1918, for yards estimated to cost aggregately about $47,000,000, and initially for 240 ships to be built at Hog Island and Bristol, Pa., called for cost plus sliding-scale fee to the contractors, which scale was essentially in principle a percentage scale.

The shipbuilding program was so complicated by various problems that the writer hardly feels competent to make an appraisal in a word of the merits of these contracts as such.

The 1918 contracts for construction of housing for shipyard workers contained substantially all the plans and specifications. Under them the government itself furnished all materials and supplies and directly assumed all classes of defined cost; the contractor could sublet only such classes of work as were specified; and his fee was a fixed one, covering profit and being in full for services of his organization and home office overhead and of the construction superintendence specifically undertaken to be furnished.

These contracts seemed to be designed fairly as to the contractor and were carried through efficiently.

IV. Status of fee contracts today

1. *Naval contracts under 1939 legislation.* Following the World War period the government departments had no authority to enter into cost-plus contracts, and employed only lump-sum arrangements after competitive bidding. On April 25, 1939, the President approved an act authorizing the Secretary of the Navy to enter into contracts "upon a cost and fixed fee basis" in the construction of certain public works of "immediate strategic importance." Between Aug. 9 and Oct. 31, 1939, three cost-plus-fixed-fee contracts were signed for work at the naval air bases in the Pacific and for work in Alaska and in Puerto Rico.

These contracts were accompanied only by general layout drawings; the contractor (including an engineering associate) must furnish all supplementary plans and specifications. Also all materials, labor and services and plant and equipment are to be furnished by the contractor, unless provided by the government; and the work is to be completed within a specified time. Substantial changes or extra work may be the subject of "an equitable adjustment of the amount of the fixed fee."

Other large contracts in practically the same form have more recently been entered into for work in Florida, in Texas and elsewhere. This contract form has just been ably explained in a pamphlet by the special assistant to the Bureau of Yards and Docks.

2. *The June 1940 legislation.* The acts of June 22, 1940, constitute a further step. The Secretary of War is authorized to employ generally in construction the "cost-plus-fixed-fee" form of contract, but is expressly prohibited from using the percentage-of-cost system of compensation. The Secretary of the Navy also, in connection with naval vessels and aircraft, is permitted to use the fixed-fee form of contract and prohibited from using the percentage form. These prohibitions were of course largely reflections of Congress' memory of the public criticism of the percentage contract—a criticism which, it seems, would have been largely averted had the percentage fee been computed on fixed scheduled costs, and perhaps wholly averted if the government further had furnished materials, as was done in some of the Shipping Board's contracts, and had also controlled labor allocations and wages.

In both Acts the Secretary is authorized to make advances to the contractor up to 30 per cent of the contract price.

QUICK SURVEY OF SOME WORLD WAR CONTRACT TYPES

Contracts for	*Form of fee*	*Chief conditions of contract*	*Effectiveness*
Army's emergency public works	Sliding-scale percentage	Work initially unplanned. Contractor's fee ranged from 10% down to 6% with a fixed maximum of $250,000, which on the average national cantonment amounted to about 3%.	High speed; fair efficiency; characterized in administration at many points by lack of economy to government.
Navy emergency public works	Fixed percentage	Work initially unplanned. Each job relatively small compared to Army jobs. Contractor's fee, 10% flat on cost of work done by himself, 5% on work done by subcontractor. No flat maximum.	High speed and efficiency. No public criticism as to economy.
Shipping Board (a) Ships and Yards	Fee in varying forms	Work planned and specified. Government option to furnish some materials. Compensation: (x) Movable "lump sum" varying with material and labor costs (either or both). (y) Cost plus fixed fee. (z) Cost plus sliding-scale flat fee essentially computed as percentage of cost.	(Not appraised.)
(b) Housing	Fixed fee	Work planned and specified. Government furnished materials. Fixed flat fee.	High speed, efficiency and economy.

V. Conclusions and suggestions

It seems in order now to state the following conclusions and suggestions:

1. *As to lump-sum or fee contracts.* In emergency public works construction the lump-sum contract resulting from competitive bidding

is a misfit. Time to prepare bids is lacking and the contractor must be selected on his standing, skill and resources.

2. *As to the government's furnishing materials and financing the work.* There may well be special reasons in an extra-continental contract, such as the Navy's recent ones, for the contractor to finance or furnish materials and labor; but it would seem that in domestic contracts we might effect large economies by relieving the contractor of these functions, for the government can buy more cheaply than the contractor. Fortunately, the principle of financing the contractor has been practically established by the recent statutes.

3. *As to controlling prices, regulating wages and allocating labor supply.* One defect lurks in any form of emergency contract that unqualifiedly reimburses the contractor for his costs. Whether his fee be a percentage or a flat figure, in competing with other contractors for available materials or for labor his zeal will tempt him into bidding up both to an extent contrary to public interest.

Is not the remedy for this plainly indicated, namely that prices, wages and subordinate salaries be controlled by the government, that it shall supply the materials and enlist and control the allocation of the labor supply? This allocation of labor could perhaps be effected, after statistical surveys, by exempting men from compulsory training or draft, conditionally on their reporting for work where assigned.

4. *As to payment for extra work.* Should not the contractor in fairness be more constructively protected than he is in the recent Navy contracts just examined, in his compensation for substantial extra work? It seems that when such extra work is ordered the contractor is in a very unequal position for safeguarding his rights; and that here is a place where compensation might perhaps well be automatically a percentage of cost of the extra work in terms of scheduled fixed unit prices and wages, a method which further legislation could validate. Of course, this extra work problem would not arise if the contract were to provide in the first instance that the contractor's fee is computed as a percentage on the basis of such fixed costs.

5. *Special use for cost-plus-fixed-fee principle of compensation where work is initially planned.* Analysis of the 1917-18 emergency contracts and their administration indicates that in a period of great stress of emergency, even where the work is initially planned and specified, a lump sum or fixed fee arrangement tends to become essentially a cost-plus-percentage contract by reason of its necessary provisos against price and wage increases. It is suggested that the principle of the fixed-fee contract, sanctioned by the 1939 legislation, can well be retained for use where the emergency work is initially planned and specified.

6. *For unplanned emergency work the safeguarded percentage fee should be sanctioned by Congress.* Inflexibility of official authority can prove most damaging in an emergency. In view of the swift results obtained in 1917-18 by Army and Navy under the percentage contract form, it could prove gravely unfortunate to have it expressly prohibited by statute.

It is therefore urged that, while retaining the fixed-fee principle for use where it is specially appropriate, Congress now also empower the officers of the government responsible for emergency public-works construction to employ the form of safeguarded emergency contract where the fee is computed as a percentage of fixed scheduled costs instead of actual costs; and that such contract principle be reinforced by contract (and statute where necessary) so that the government furnishes materials, regulates wages, allocates labor and directly finances job costs.

If the present emergency should become more acute, it does seem, in the light of our 1917-18 experience, that the government should vest its officers now with powers broad enough to enable them to do what must be done in this or in any later stage of the emergency.

Weight of Pile Hammers

THE COMMITTEE on wood bridges and trestles of the American Railway Engineering Association, in its report to the recent convention of the association, submitted new recommendations as to the relation between the energy of piledriving hammer and the mass of the pile. These recommendations are now before the association for discussion. If approved, they will be included in the association's manual at some later date. The recommendations are as follows:

In determining the weight or size and capacity of the hammer to be used for any service, due consideration must be given to the weight and spacing of the piles, the character and condition of the soil to be penetrated, conditions of driving, and former experience at the site or under similar conditions. The blow should be struck by a ram having sufficient energy to overcome the inertia of the pile and the frictional and elastic resistance encountered, and having sufficient weight to reduce to a minimum the portion of this energy which is unavoidably dissipated in destructive work during impact. As a general rule, piles should be driven with the heaviest hammer that, in the judgment of the engineer, can be used to secure maximum penetration without appreciable damage to the pile.

Steam Hammers—For driving concrete piles, the striking part of the hammer should weigh not less than 2,500 lb. and develop energy per blow of 8,750 foot-pounds per cubic yard of concrete contained in the pile to be driven.

For the driving of timber piles, the weight of the striking part of the hammer should be not less than the weight of the pile to be driven. In general, the minimum weight of the entire hammer and of the striking part, and the length of stroke should, where practicable, be specified for each project. Where hard driving is encountered, it may be necessary to reduce the length of stroke in order to avoid injury to the pile.

Gravity Hammers—For driving either concrete or wood piles, the weight of the striking ram shall be not less than 3,000 lb. and the drop shall be so regulated as to obtain the desired penetration without appreciable injury to the pile.

Hand Mining on Chicago Subways

***Contents in Brief**—Chicago is building the first stage of a comprehensive subway system by tunneling 7.7 miles of double-track tubes. Of this total 4.6 miles is being built by hand-mined tunneling, an elaboration of long-established soft-ground methods developed on Chicago sewer tunnels, improved by eliminating the usual needle beam through adoption of a better steel rib and plate ground support and consistent use of compressed air up to 12-lb. pressure. Multiple bench tunneling and coordinated daily placement of concrete lining have been worked out to perfection.*

EXPERIENCE GAINED in building many miles of large sewers by compressed-air tunneling through Chicago's soft blue clay is being used to good advantage in both the design and construction of the hand-mined tunnel sections that make up 4.6 miles of the 7.7-mile length of the first stage of the Chicago subway system, now under construction. The subway is a fast-schedule PWA project, and to get going in a hurry, experienced sewer designers were transferred from the Sanitary District of Chicago to design the subway structure. Chicago contractors, all of whom have driven sewer tunnels, were successful bidders on the various subway sections, and they set out to improve on long-established local soft-ground tunneling methods by eliminating the usual needle beam and jacks for supporting the ground. Improvements in multiple-bench mining and the design of steel rib and plate timbering, coupled with coordinated concrete lining that keeps the concrete close to the face mark the construction progress.

General Scope of Work

The first stage of the subway system, which will eventually extend to 50.5 route miles, is being built at a cost of $46,000,000, of which $18,000,000 is a PWA grant; the remaining $28,000,000 was appropriated from the city's traction fund. The present work (Fig. 2) covers two routes, known as the State St. and Dearborn St. lines.

After a considerable amount of controversy over the merits of shallow open-cut construction and deep tunnel lines, the latter type was finally chosen, placing the base of rail about 43 ft. below street level. Because the blue clay underlying all of Chicago is softer and more plastic in the Loop business district than elsewhere, and because of numerous buildings on spread footings and the multitude of utility lines in the streets, the shield method of tunneling was specified for the State and Dearborn St. sections south of Lake St. Elsewhere, except for a fabricated tube sunk in a dredged trench for the State St. crossing of the river, hand mining with plate and rib ground support was considered satisfactory.

There are five general types of structure in the non-shield-driven sections: separate single tubes; twin tubes with common center wall; twin tubes with side platforms in station; separate tubes with center station platform between them; and wide-span crossover sections. The shape and dimensions of the first four types are shown in Fig. 3.

Because of the fast schedule of 24½ months allowed, the construction work was divided into short sections to insure early completion. The hand-mined tunnel contracts are listed in the accompanying table. All these sections, totaling nearly 5 miles, are practically complete.

CONTRACTS ON HAND-MINED SECTIONS, CHICAGO SUBWAYS

Contr.	Length ft.	Date Let	Value	Contractor	Supt. in Charge
S4-B	1,099	10–23–39	$803,221	John C. Tully Co.	Chas. Schuessler
S5	3,635	12–13–38	2,744,605	Herlihy-Mid-Continent Co.	Chas. Herlihy
S6	4,534	9–19–39	2,986,590	M. J. Boyle & Co.	Harvey Kruse
S7	4,000	2– 9–39	2,445,666	M. J. Boyle & Co.	Harvey Kruse
D3	4,212	7–13–39	3,189,849	Paschen Contractors, Inc.	Mike Dillich
D4	3,448	3–14–39	2,094,766	John Marsch, Inc.	Roy Shackleton
D5	3,577	2–28–39	1,874,320	Michael Pontarelli & Sons	I. H. Baker

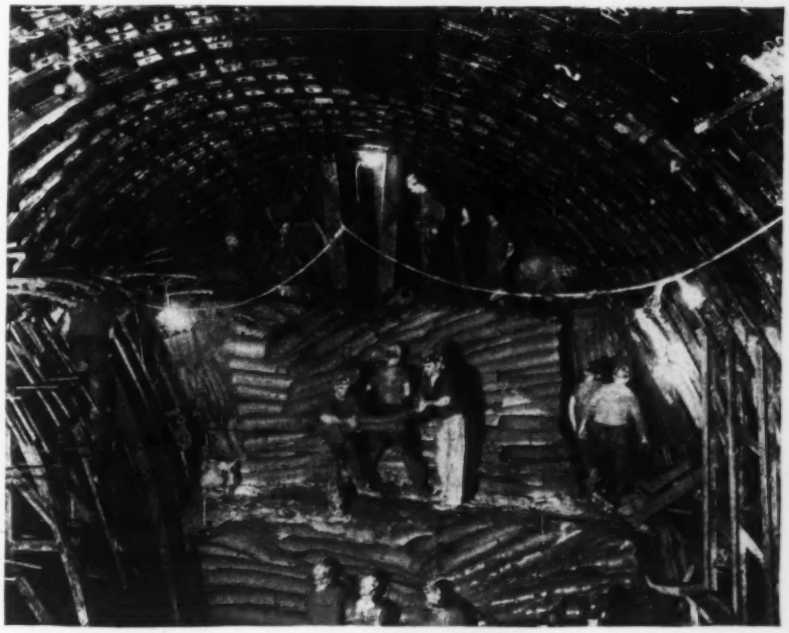


Fig. 1. Slicing slabs of clay in bench and heading subway driving.

Space for top plant was limited on every contract. Except in three instances, where crossovers were built in open cut, no obstructions were allowed in the street, not even shafts to the tunnels. Consequently contractors had to obtain working space on private property, sink a shaft and drive a drift between shaft and tunnel line. In general the shafts were 15 ft. in diameter, sunk by excavating with a crane and clamshell inside of steel rib and plate lining. Over each shaft was built a headframe to accommodate two hoist cages. Headframes were either steel pipe or structural steel construction, and carried bins or chutes for dumping the muck into trucks. Most of the contractors used side dump cars, which discharged into the bin or chute from position on the cages, but Boyle built a tipple

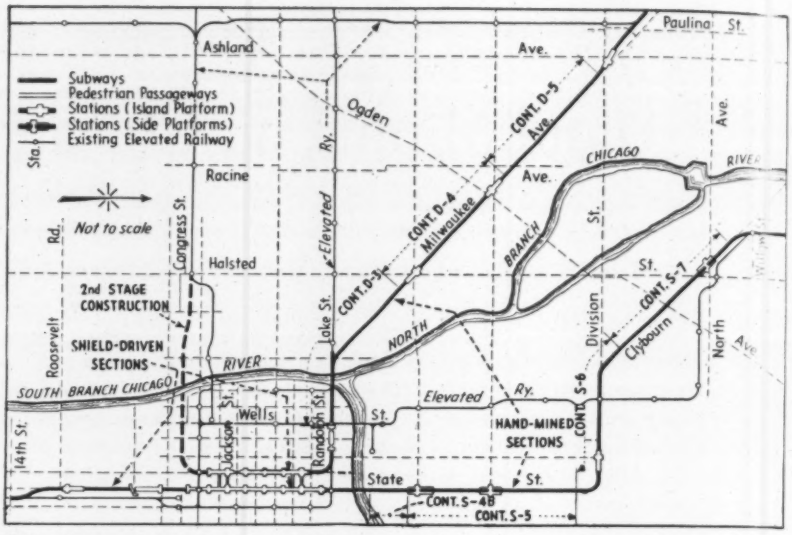


Fig. 2. Map of initial stages of Chicago subway system. The sections south of Lake St. are shield-driven, all others are hand-mined under compressed air.

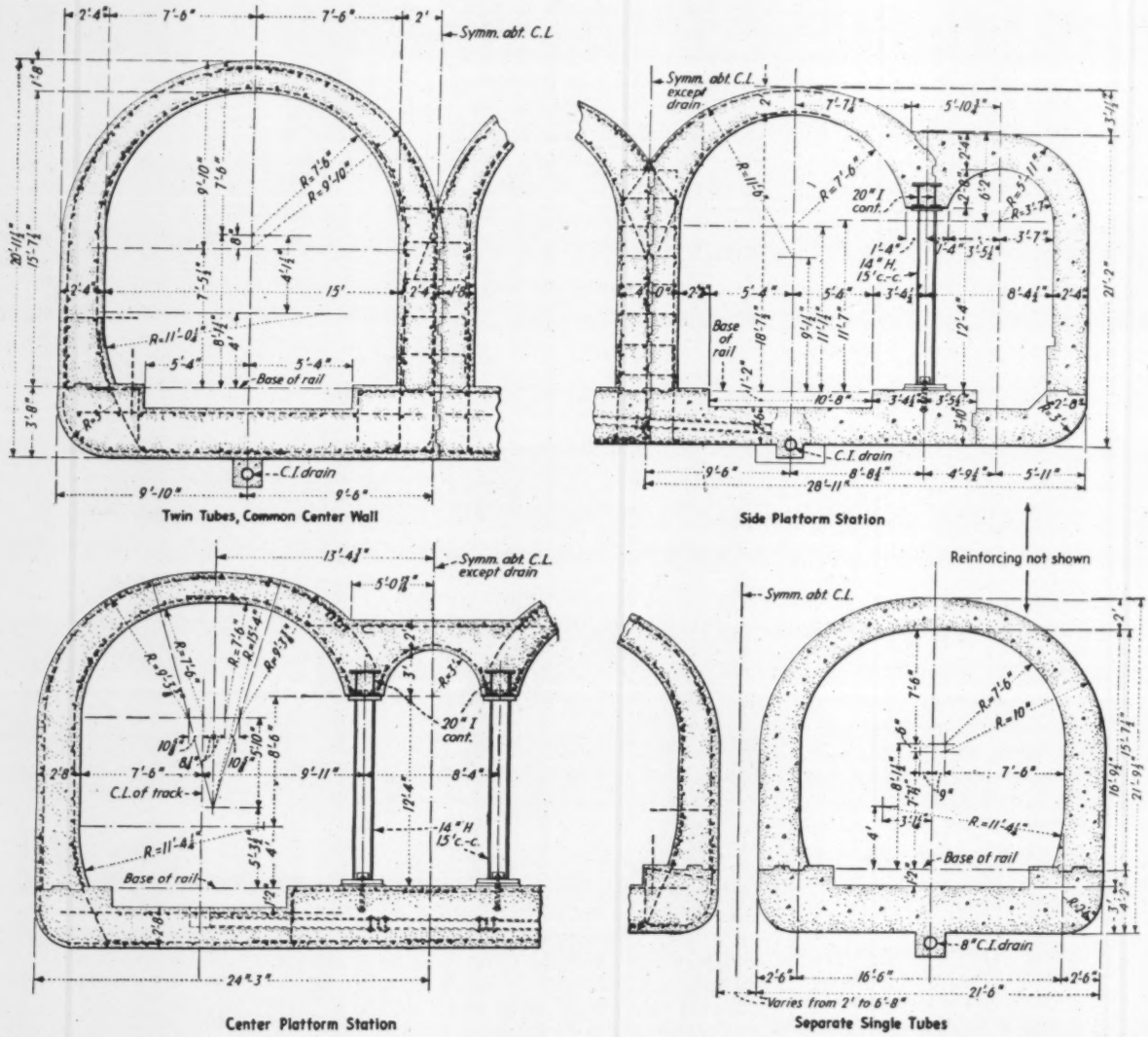


Fig. 3. Four of the five general types of non-shield-driven, heavily reinforced subway sections outside the Loop.

alongside the headframe, ran the cars off the cages and dumped them with a rotary car dumper.

An exception to the usual shaft and drift layout was made by Tully, who built the crossover on his job in open cut first, then operated from the open cut, placing the airlocks in the main tunnels. All other locks were installed in the drifts between the shaft and tunnel.

The top plant of all contractors was similar, and included transformer station, compressor plant, electric cage hoist, change houses, battery charging stations for the tunnel locomotives and shops. Storage space was at a premium, necessitating a careful scheduling of steel and other required material. All muck was hauled away in trucks, usually to barges for lake disposal.

Steel ground support

There were two general types of steel rib and plate ground support on the seven contracts. One type, used only by Herlihy on the first contract let, consisted of seven-section continuous ribs and posts without wall plates. The system proved rather unwieldy to handle, so all the other contractors turned to a design of steel support with wall plates at the springline. Ribs and posts were of three general sizes and weights, 6-in. 16.5-lb., 6-in. 20-lb., and 7-in. 15.8-lb. H-sections. Holes were punched in the ribs to pass longitudinal reinforcing bars. Wall plates were mostly 8-in. 24-lb. H-sections, laid with web horizontal. In the wall plate system the arch ribs were in two or three sections, resting on the wall plate web; the wall plate, in turn, was carried by straight rib posts placed directly under the arch ribs. The ribs were spaced from 26 to 30 in. apart, depending upon type of liner plate used.

Fig. 4. Monkey drift for wall plate, carried ahead of top heading excavation. The wood lagging is in top heading area, and will be removed when second of twin tubes is driven.

Because of omission of the wall plate, Herlihy used a peculiar vertical truss bracing at the lower ends of the ribs. Outside of station areas these trusses consisted of king posts and a pair of ¾-in. rods, supplemented by 7-in. channels along the rods which were removed before concrete lining was placed. King posts and rods were buried in the concrete. Drums or struts fitted with jacks at one end to prestress the timbering system were placed across the tunnel against the king posts. The drums were removed after the invert was poured, and the lower ends of the trusses and ribs concreted in. In station areas the trusses were structural steel with a vertical chord member extending almost to the top of the second section of the rib. These were fabricated in pairs with cross-bracing. One drum engaged a pair of ribs.

Liner plates varied in type. Herlihy used an unusually long plate, consisting of a ¾-in. curved steel sheet 25¾ in. wide (between ribs) and varying from 22 to 33 in. long, flanged along the edges for bolting to the ribs and divided into three or four panels by ¾ x 2½-in. bars welded to the plate. The end bars were drilled for bolting adjacent plates together. On other sections a conventional flanged liner plate was used, which bolted between the ribs. Later, on some contracts, this type was replaced by flanged plates flattened at the ends to bear against the outside of the outer flange of the ribs. These

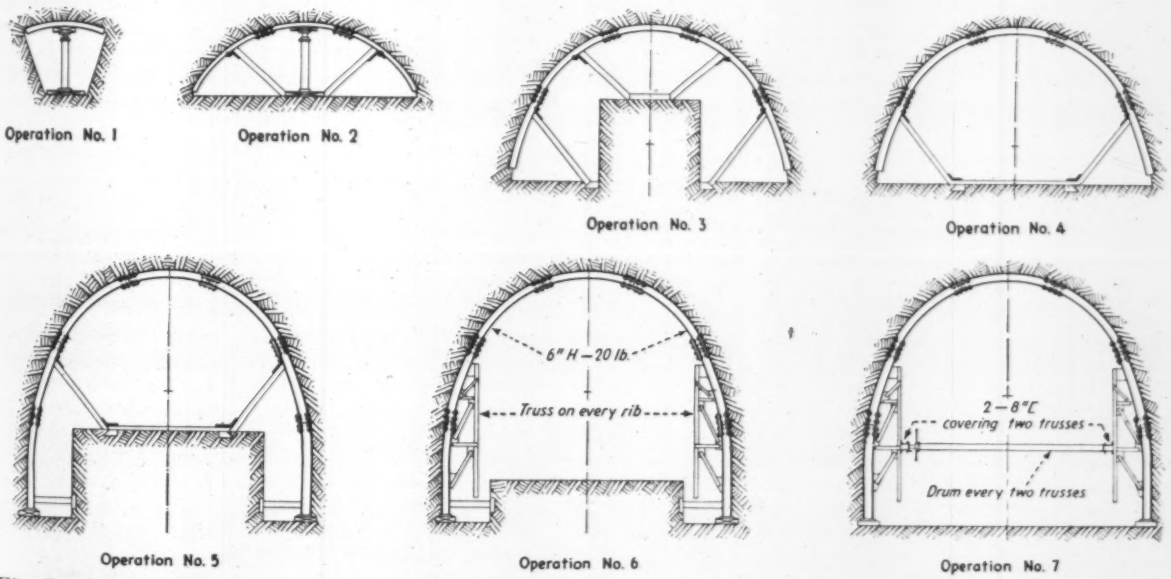


Fig. 5. Diagram of progressive excavation operations on Herlihy's contract. Each step is carried ahead of the succeeding one at least the width of two ribs.

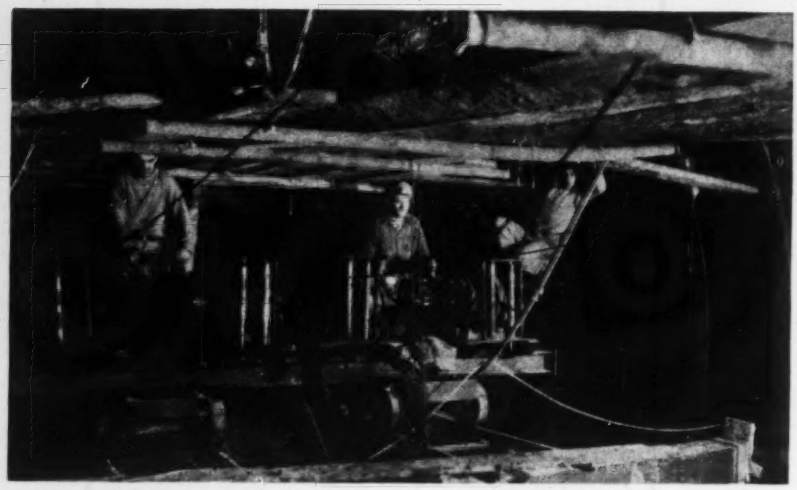


Fig. 6. Battery of four air hoists operating the power knives on Boyle's job. Each operator runs two hoists, keeping watch of two knives at the same time. Note rail mounting of hoists; the track rides on the wall plate drums.

were placed by entering them behind the ribs at the crown one at a time, then sliding them toward the wall plate to butt against the previously set liner plate.

Timbering for the side platform section of stations was similar to the main tube steel, consisting of one leg and the arch rib resting on previously set ribs of the tubes. Center platform ground support required only flat ribs resting on the previously set tube ribs.

In the twin tube section, with common center wall, one tube was driven ahead with the same type primary lining as for single tubes. For the second tube, following some distance behind, the steelwork was similar to that of the first tube, except that no post and wall plates were required on the common wall side; instead, the arch ribs rested on clip angles fastened to the outside of the first tube arch ribs. Sometimes wood lagging replaced the plates in the common wall area, as both ribs and sheeting had to be removed before the second tube portion of the common wall was poured.

Turning the eye

One of the most interesting operations of each job was turning of the eye, or starting the tunnel from the drift. Herlihy entered the tunnel at a side platform station section. From the end of the access drift he carried a monkey drift 5 ft. wide across the first tunnel, following around just under the arch of the railroad tube, ignoring the side platform arch for the moment. Next, he started small drifts parallel to the main tunnel axis both ways at the crown of the first tube. Steel rib and plate support for these drifts was posted to the bench; as the drifts progressed the heading was widened out by benching down until the full section of tunnel was opened. Then the concrete invert was poured and the routine tunneling operations begun. The second tube was started in the same manner.

Pontarelli entered the tunnels at a separate single tube section with a somewhat different method. He placed a timber frame across the mouth of the access drift to act as a wall plate for the arch ribs. Then he excavated a drift into the first tube wide enough to accommodate two arch ribs, digging upwards toward the crown, then down to the opposite wall, leaving the center of the tube section undisturbed. The steel ribs were posted to the floor of the excavation. Next, the drift was widened out at wall plate level to allow setting of a 15-ft. length of wall plate beam, after which two vertical posts were placed under the ribs and a hole dug to invert level. The original cross drift was then widened out in steps. Finally, the invert was poured in the tube section, and driving started both ways. The same procedure was used to start the second tube.

Marsch used an entirely different method for starting the tunnels, though he also entered from the access drift at a separate single tube section. He extended the access drift, with its arched roof, to the far side of the second tube, placing invert concrete in the main tube section. Then four timber frames were built across the drift with caps at wall plate level. A narrow monkey drift

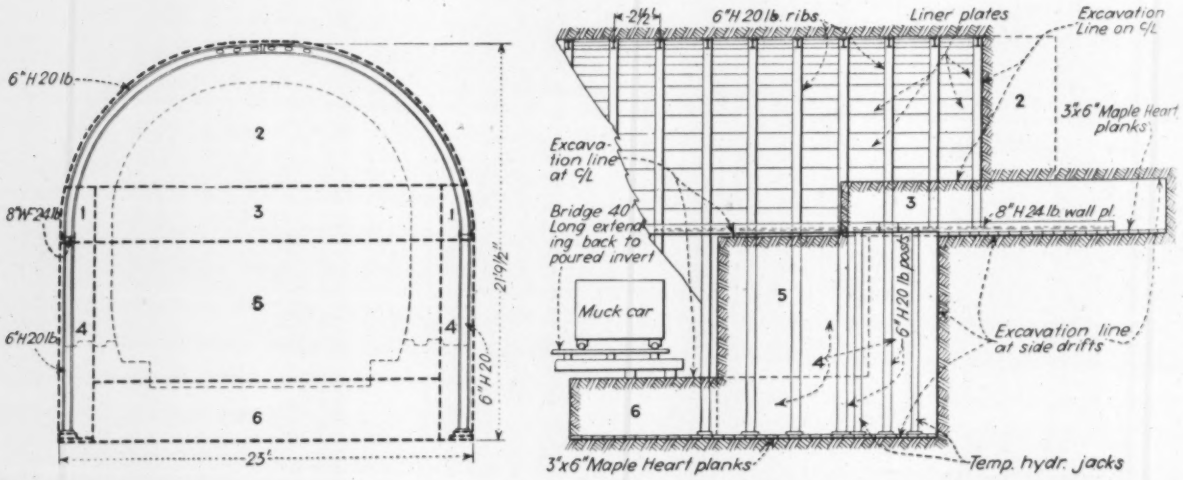


Fig. 7. Diagram of excavation steps on Boyle's two contracts, typical of all sections where wall plates were used.

was driven across the arch of the first tube, with wood lagging braced to the tops of the steel ribs of the access drift below. Then as this monkey drift was widened out, arch ribs of the first tube were set to bear against the timber frames. When widening had progressed beyond the timber frames regular mining procedure was established. Entering the second tube was accomplished by the same method.

Hand mining procedure

Excavation procedure was based on peculiar characteristics of the Chicago blue clay, which is of a consistency that permits slabs or slivers to be cut from the mass of clay by U-shaped hand or power knives, yet is stiff enough to hold, for a short time at least, almost any shape without flowing or distorting. Two general arrangements of drifts and benches were used, depending upon the type of steel timbering utilized.

Herlihy, using steel ribs and plate without wall plates, had to devise a system of benches that permitted temporary posting of the ribs. He started with a top center drift, then in three additional steps widened and deepened the top heading to full width below springline, installing five sections of arch ribs and corresponding plates. In longitudinal direction each step was carried the width of two ribs, about 4½ ft., behind the preceding step. Next, bottom side drifts permitted completion of the ribs, and in two more steps the bottom bench was removed, the vertical trusses placed on the lower ends of the ribs and the cross-drums installed. The various steps are shown in Fig. 5. Disadvantages of the system were the continuous posting that interfered with excavation, and the short benches, which invited earth movements due to the relatively short longitudinal distance between top drift and full size tunnel.

The heading and bench arrangement used on the two M. J. Boyle & Co. jobs was typical of that on all the other contracts where wall plates were used in the ground support system (Fig. 7). First wall plate drifts, 2 ft. wide and 3 ft. high, were driven with floor at wall plate level, and carried ahead a maximum of 12½ ft., the length of the wall beam. The floor of these drifts was paved with 3x6-in. maple heart planks, set crosswise, upon which the wall plate section was

Fig. 8. Concrete for the lining is delivered to the tunnels through pipes from the surface. Here, discharge is into a pump hopper.

then placed, with web horizontal, jacked down from the roof of the drift to insure a firm bearing. No support or timbering was required in these small drifts.

The next step was excavation of the top heading above the level of top of wall drifts, cut close to the curved outline of the arch. As soon as this heading had advanced the width between ribs, a new arch rib in two or three sections was erected by hand. The new ring of plates was then placed as soon as possible, either bolted to the ribs or set outside the back flange, depending upon type used. The flat-end plates were not bolted, so a few small angle sections bolted between ribs acted as both ties and struts. Thus, in two steps the arch above springline, the vital part of any soft ground tunnel job, was caught and securely held.

Following well behind the top heading was the third step of excavation, clearing out the bench between bottom of wall plate drifts and the floor of the top heading. This step was purposely delayed to provide a long bench as a buttress for the top heading face.

Following from 8 to 12 ft. behind the top headings was the fourth stage of excavation, which consisted of narrow wall drifts the full height of bench from invert to wall plate. These drifts provided space to set the posts or legs of the timbering system. The floor of the drifts was paved with maple heart planks and the posts rested on blocks placed on the planking. Posts were set just as soon as the drift excavation had advanced far enough for another unit, always placed directly under the arch rib. The posts were placed with the aid of steel pipe hydraulic jacks as long as the post section. The jacks were worked in pairs, so one was always in place holding up the wall plate as the other was moved forward. They also served to shove the arch steel tight against the roof to preclude any settlement of ground.

The fifth and sixth stages of excavation were benching down of the remainder of the tunnel section between wall post drifts. Boyle used a bridge to span between the top of invert concrete and the top of the sixth or last bench. The bridge, which carried two tracks for muck cars, extended far enough over the bottom bench to permit excavation of most of this bench by undercutting. The bridge also provided a clear span over the new invert pour, which meant that the invert steel could be placed without interfering with most of the excavation. Other contractors stopped all excavations in a heading when getting ready for concrete.

Actual excavation was by paring off slivers and slabs of clay with power knives, nothing more than U-shaped cutters pulled by a cable and air hoist arrangement. The knives were worked in any direction desired —vertically or horizontally, in transverse or horizontal direction — through snatch blocks hooked to the steel ribs or wall plates. The air hoists were set back in the clear, often on platforms resting on cross-drums bearing against the wall plates. The clay slabs were thrown, carried or passed forward to the cars below. The benches and drifts vary in size, so the men are distributed on the basis of 3 yd. of excavation per man per shift, except for the wall plate drifting, where two men are able to make the required progress working with short-handled and short-bladed spades.

In separate single tube sections the headings of both tubes progressed together. Frequent permanent connections between the tubes provided ac-

cess from one to the other. In the twin tube section where the tubes had a common center wall, one tube was pushed ahead as a complete tunnel, the other followed some distance behind after the concrete lining of the first was well set.

Special excavation methods

In station areas the usual procedure was to drive the tubes first by the method outlined above, except, of course, that the steel columns and longitudinal beams replaced the concrete walls along the platform sections. Then, far behind routine tunneling, top heading drifts were driven for the arch of the platform section. In center platform sections the only timbering required was the flat roof beams and plates.

The contractors could build the crossover sections in open cut or tunnel as they preferred. Boyle chose to use the tunnel method, and a clever scheme of operation was successfully carried out by Harvey Kruse, the superintendent. The design called for a wide arch of 35½ ft. clear span, with walls and invert thickened to 4 ft. 9 in. and the roof to a minimum of 3 ft. As the crossover on Boyle's job came in a separate tube section, both tubes were driven in normal fashion, except that concrete lining was placed only in the invert and outside walls up to 3 ft. above springline. The next step was to install 12x12-in. timber posts, 10 ft. c. to c., capped by a longitudinal 12x14-in. timber, just inside the centerline of each tube to shore up the original arch ribs. Then a small triangular drift was driven over the tops of the original ribs, outward from the centerline of each tube, to install the lower or haunch section of ribs, to carry the big arch. These ribs, 10-in. 33-lb. sections, were placed between the original ribs; their lower end rested in a hitch left in the top of the first section of concrete wall. The inner or free ends of the big ribs were posted to the cap of the temporary shoring system. Then the second or upper haunch section of concrete was placed.

Following well behind the haunch work was the third step of building the arch. A top heading was driven between the haunch concrete sections and two sections of rib installed to complete the steel arch. These were temporarily posted to the floor of the drift until the rib section was bolted in place. Then the posts were taken out, forms installed, braced to the original tube ribs and the top drift floor, and the crown section of concrete poured. The arch was now complete, and the excavation remaining between the two tubes below the top heading could be taken out at leisure. The original ribs were burned off back of the concrete face in recesses left for that purpose.

Concrete lining

In general, concrete was mixed at the surface in pavers and delivered to the tunnel through pipes, fitted with airlocks, in drill holes, sunk from street level. Several schemes were used for handling concrete inside the tunnel. Some contractors used concrete pumps or pneumatic placers located under hoppers at the delivery pipes from the surface, pumping or blowing the concrete direct to the form. Others hauled mixed concrete in cars direct to the invert pours, and to pneumatic placers for side walls and arch. One contractor used a pump at the suface, pumping directly into the forms.

Most contractors averaged 15 ft. a day in each heading by mining out 30 ft. in three straight shifts, then stopping to pour 30 ft. of invert and arch in the next three shifts. The arch forms were kept one day's pour behind the invert, which was never open for more than 20 ft. at a time. Boyle, however, doubled the daily progress through use of the invert bridge mentioned above.

Direction

The subways are being built as a PWA project by the Chicago Department of Subways and Superhighways, Philip Harrington, commissioner. Ralph H. Burke is chief subway engineer. P. F. Girard is engineer of subway design; A. M. Crain is in charge of all construction. Chas. E. DeLeuw is consulting engineer, and Joshua D'Esposito represents PWA.

Twin Floods Hamper Flood Control

The phenomenon of two major floods in close succession, sometimes called a "twin flood", which is peculiar to many drainage areas in the United States, is a factor that should be considered in both design and operation of flood-control reservoirs, according to the 1939 progress report of the American Society of Civil Engineers committee on flood-protection data. An 8-day or shorter interval between two major flood peaks usually imposes a more severe test on the adequacy of flood control by reservoirs than does a single maximum flood. The operating problem is not so much the impracticability of emptying reservoirs in the short interval, but rather the releasing of sufficient water from storage to reduce the peak of the second flood crest.

Whenever the streams below the reservoir continue to run bank-full and release of water is inexpedient, the operator is faced at the approach of the second storm with the dilemma of having to release water too late to provide adequate storage capacity.

Among cases cited by the committee is the flood on the Colorado River at Austin, Tex., in 1936. A storm in the upper drainage area caused a flood which reached a 25-ft. stage at Austin on Sept. 22. A second storm lower down on the drainage area caused a crest stage of 32 ft. on Sept. 28. Both floods were destructive. The great damage by the February-March floods in Los Angeles county in 1938, in spite of the existence of 13 flood control reservoirs, is attributed to two intense storms on Feb. 27-28 and March 2-3. The latter gave the most intense rainfall and peak runoff rates. On March 2, all the reservoirs were more than half full, and as the runoff on that day alone was in excess of the total storage capacity, the reduction in peak flow was necessarily small. The interval of less than one day did not permit the release of much of the water already in storage. This situation was aggravated by debris clogging the outlets at six of the dams.

Earth Pressure on Wall of Varying Height

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THE FOLLOWING METHOD of evaluating the earth pressure on a wall of varying height gives the designer the entire pressure (P_1) on the wall, and the moment of this entire pressure (M_B) about the bottom of the wall. It thus obviates the process of summing up several prisms and pyramids whose separate pressures and pressure arms otherwise must be calculated and added together.

In the derivation, w is the unit pressure of earth, such as 30 lb. per sq. ft. per ft. of height and p is the total pressure on a vertical section of wall of unit length. P, P', M_A and M'_A are intermediate summations which combine to form the final summations P_1 and M_B.

In the sketch, the general case of a wall having both top and bottom sloping, it is convenient for the purpose of deriving the formulas to divide the figure into two parts by a horizontal plane through the base of whichever wall end is the higher of the two. In this case y_1, y_2 and y_3 are the end heights of these wall portions while y is a typical height of the wall above the horizontal plane.

Below the general formula for M_B are appended special formulas for use in cases where either top or bottom or both top and bottom of the wall are level.

Forces above A

$$p = wy^2 \div 2 = w\left[y_1 + \frac{x}{l}(y_2 - y_1)\right]^2 \div 2$$

$$= \frac{w}{2}\left[y_1^2 + \frac{2y_1x}{l}(y_2 - y_1) + \frac{x^2}{l^2}(y_2 - y_1)^2\right]$$

$$\Sigma p = \frac{w}{2}\left[y_1^2 x + \frac{2y_1(y_2 - y_1)x^2}{2l} + \frac{(y_2 - y_1)^2 x^3}{3l^2}\right]_0^l$$

$$= \frac{wl}{2}\left(y_1^2 + y_1y_2 - y_1^2 + \frac{y_2^2 - 2y_1y_2 + y_1^2}{3}\right)$$

$$= \frac{wl}{6}(y_1^2 + y_1y_2 + y_2^2) = P$$

Moment of p (above A) about A

$$= wy^3 \div 6 = w\left[y_1 + \frac{x}{l}(y_2 - y_1)\right]^3 \div 6$$

$$= \frac{w}{6}\left[y_1^3 + \frac{3y_1^2x}{l}(y_2 - y_1) + \frac{3y_1x^2}{l^2}(y_2 - y_1)^2 + \frac{x^3}{l^3}(y_2 - y_1)^3\right]$$

$$\Sigma M = \frac{w}{6}\left[xy_1^3 + \frac{3y_1^2x^2}{2l}(y_2 - y_1) + \frac{3x^3}{3l^2}(y_2 - y_1)^2 + \frac{x^4}{4l^3}(y_2 - y_1)^3\right]_0^l$$

$$= \frac{wl}{6}\left[y_1^3 + 1.5\,y_1^2(y_2 - y_1) + y_1(y_2 - y_1)^2 + \frac{(y_2 - y_1)^3}{4}\right]$$

$$= \frac{wl}{24}\left[y_1^3 + y_1^2y_2 + y_1y_2^2 + y_2^3\right]$$

$$= \frac{wl}{24}(y_1 + y_2)(y_1^2 + y_2^2) = M_A$$

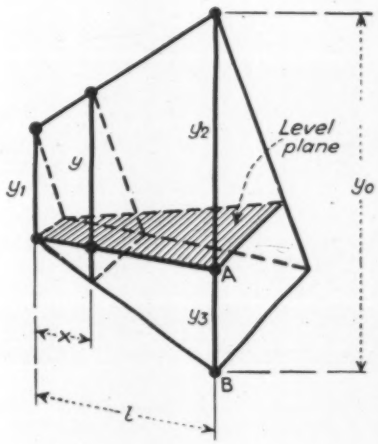
Forces below A

$$p = wy_3\frac{x}{l}\left[y_1 + \frac{(y_2 - y_1)x}{l} + \frac{y_3x}{2l}\right]$$

$$\Sigma p = \frac{wy_3}{l}\left[\frac{x^2y_1}{2} + \frac{x^3}{3l}\left(y_2 - y_1 + \frac{y_3}{2}\right)\right]_0^l$$

$$= wly_3\left(\frac{y_1}{2} + \frac{y_2}{3} - \frac{y_1}{3} + \frac{y_2}{6}\right)$$

$$= \frac{wly_3}{6}(y_1 + 2y_2 + y_3) = P'$$



Moment of p (below A) about A

$$= -\frac{wy_3x}{l}\left[\left((y_1 + \frac{(y_2 - y_1)x}{l}\right)\left(\frac{y_3x}{2l}\right) + \frac{y_3}{2}\cdot\frac{x}{l}\cdot\frac{y_3 \cdot 2x}{3l}\right]$$

$$= -\frac{wy_3}{l}\left[\frac{y_1y_3x^2}{2l} + \frac{y_2y_3x^3}{2l^2} - \frac{y_1y_3x^3}{2l^2} + \frac{y_3^2x^3}{3l^2}\right]$$

$$\Sigma M = -\frac{wy_3}{l}\left(\frac{y_1y_3x^3}{6l} + \frac{y_2y_3x^4}{8l^2} - \frac{y_1y_3x^4}{8l^2} + \frac{y_3^2x^4}{12l^2}\right)_0^l$$

$$= -wy_3l\left(\frac{y_1y_3}{6} + \frac{y_2y_3}{8} - \frac{y_1y_3}{8} + \frac{y_3^2}{12}\right)$$

$$= -\frac{wly_3^2}{24}(y_1 + 3y_2 + 2y_3) = M_A'$$

Total forces, above and below A

Force $P_1 = \frac{wl}{6}(y_1^2 + y_1y_2 + y_2^2) + \frac{wly_3}{6}(y_1 + 2y_2 + y_3)$

$$= \frac{wl}{6}\left[y_1^2 + y_1(y_2 + y_3) + (y_2 + y_3)^2\right]$$

$$= \frac{wl}{6}(y_1^2 + y_1y_0 + y_0^2)$$

Moment M_B = Moment of total forces about B

$$M_B = \frac{wl}{24}\left[(y_1^2 + y_2^2)(y_1 + y_2) - y_3^2(y_1 + 3y_2 + 2y_3)\right] + P_1 \cdot y_3$$

Special cases

If top of wall is level,

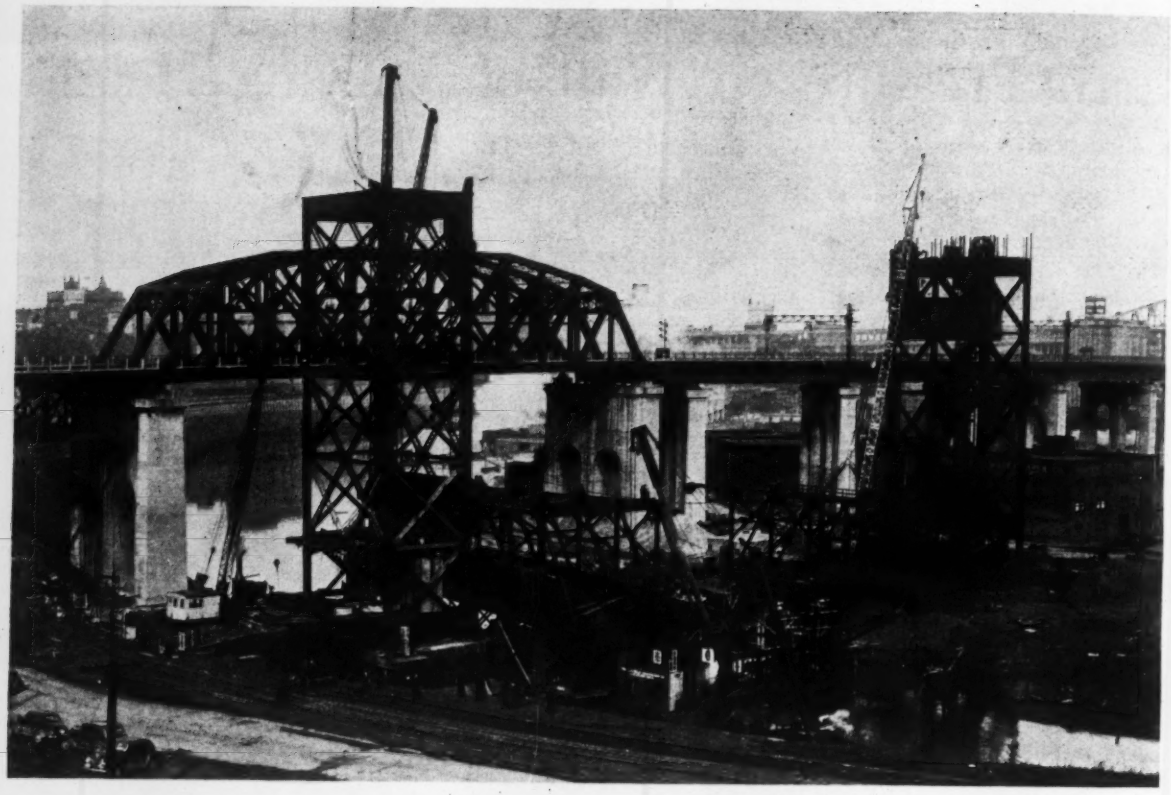
$$M_B = \frac{wl}{24}\left(4y_1^3 - 4y_1y_3^2 - 2y_3^3\right) + P_1 \cdot y_3$$

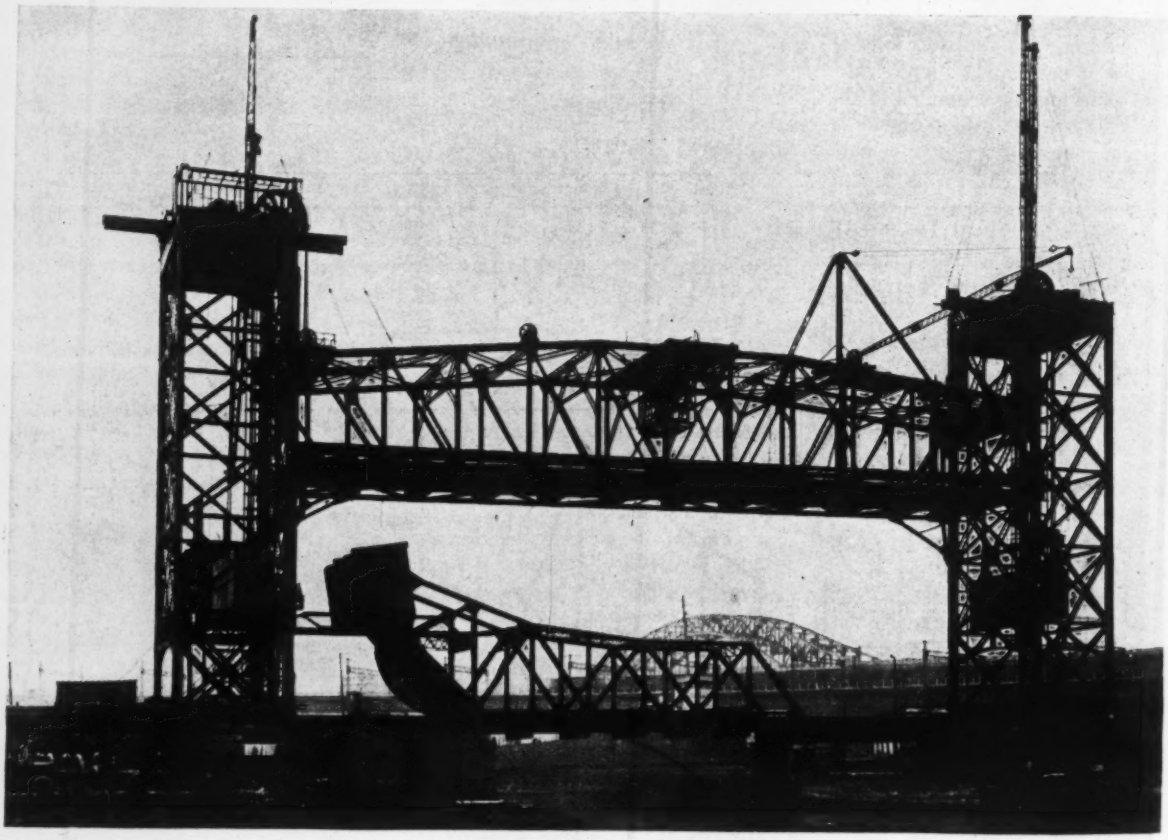
If bottom of wall is level,

$$M_B = \frac{wl}{24}\left(y_1 + y_2\right)\left(y_1^2 + y_2^2\right)$$

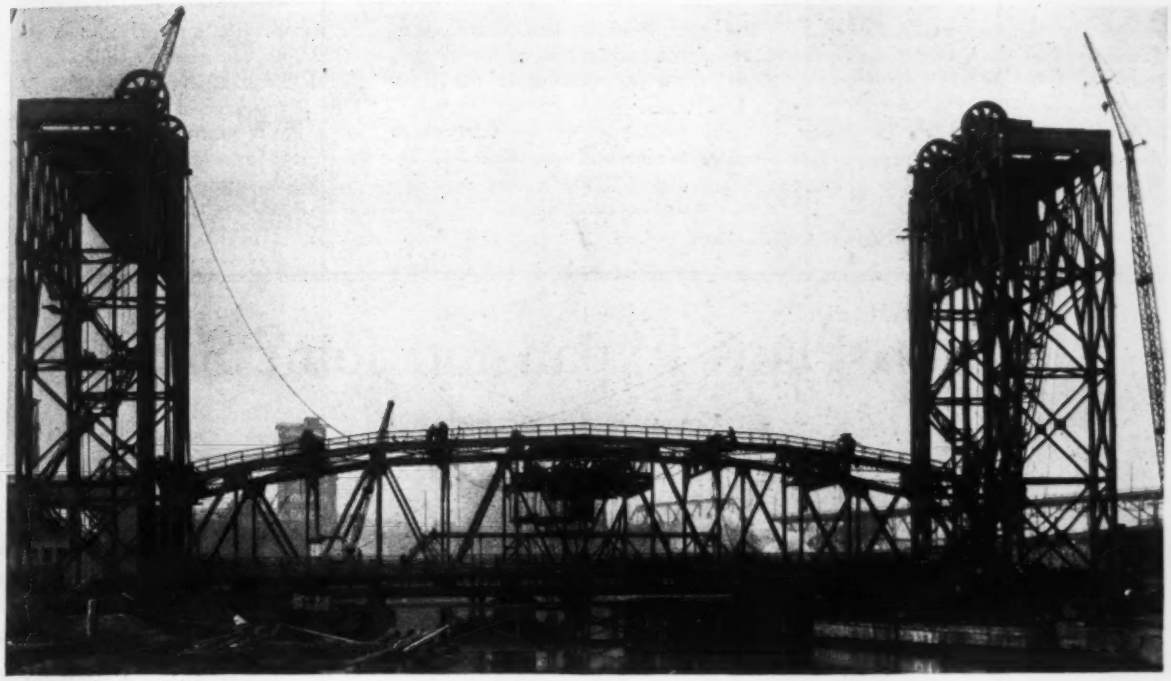
If both top and bottom are level,

$$M_B = \frac{wl}{6}y_1^3$$





Columbus Road Bridge; four panels erected on timber bents, remainder of span erected on barges and floated to place. Below, Carter Road Bridge, cantilevered from towers in the raised position.



WEST THIRD ST. BRIDGE ERECTED BY FALSEWORK.

Three Methods for Erecting Lift Bridges

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LIFT-BRIDGE CONSTRUCTION on the Cuyahoga River improvement presented an interesting contrast of erection methods under almost identical conditions. Three new vertical-lift highway bridges of the same size and general design have been erected by three different contractors, each using a method of his own and each apparently well satisfied with the results achieved. As work began in November and December, most of the erection had to be carried out during unusually severe weather.

The bridges are part of the city's $5,500,000 program of widening and straightening the Cuyahoga River (*ENR*, Oct. 13, 1938, p. 448). This project involves the elimination of three sharp bends in the river, including the notorious Collision Band, which will permit the largest lake freighters, 625 ft. long by 70 ft. beam, drawing as much as 23 ft., to reach blast furnaces up the river as well as facilitate river shipping in general. For the foundation construction see *ENR*, Oct. 26, 1939, p. 541.

The Wisconsin Bridge & Iron Co., which fabricated and erected the Columbus Road bridge, adopted a combination of falsework erection and floating-in. Four panels of the river span, extending over the present land area where the channel is to be widened, were erected on falsework bents. Seven panels of the span were erected on two barges a few hundred feet downstream, and when completed were towed upstream and moved into place so that the section of span on the barges could be picked up and set on the river pier at one end and a pair of timber bents at the other. When the two parts of the bridge were thus in proper alignment, the barges were removed and the connecting members were entered and riveted up.

Carter Bridge was fabricated by Mount Vernon Bridge Co. and erected by cantilevering out from the towers, which had been designed strong enough for the purpose. Temporary kneebraces from the first panel point of the span down to the next panel point of the tower assisted in carrying the cantilever. The bridge was erected about 7 ft. below the maximum clearance position. Erection was somewhat slowed up by weather conditions, which affected operations high in the air. This bridge as well as that at Columbus Road was erected by the Bass Construction Co., by methods planned by the fabricating companies.

West Third St. Bridge, built by R. C. Mahon Co., was erected on a falsework trestle. The towers had been erected from the ground by a crawler crane with very long boom, and the 13-ton counterweight sheaves hoisted to the tower top by a boom set on top of the tower. The span was erected in low position on

temporary wooden trestle driven in the river. The span was lifted to the tower tops by its auxiliary gasoline engine power plant.

With the three bridges in service, the entire river improvement was completed by July 1. It was planned and completed in two years' time, though including two miles of new steel dock in addition to the three lift bridges.

The total cost of the thirty-three contracts involved was about $4,250,000, land cost $805,000, and engineering, inspection and extra work about $250,000. The project thus was kept below the original estimate of $5,500,000. It was carried out with assistance of a PWA grant under direction of the city, for whom the writer is acting as consulting engineer.

Oregon Plans Expansion Joint Study

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Contents in Brief—Experiments on a section of concrete paving near the Oregon state capital involving five types of expansion joints have the twofold purpose of rating the relative effectiveness of load transference in such joints and comparing the effect of expansion joint spacings ranging from 30 to 495 ft.

IN A RESEARCH PROJECT now being carried on by the Oregon State Highway Commission, observations on expansion joint behavior are being made regularly on a 1.59-mile section of the Pacific highway south of Salem, Ore. The pavement, built by contract late in 1939, is portland cement concrete, 22 ft. wide with a 9-7-9-in. section, supported on a 6-in. compacted crushed-rock base. Five types of expansion joints are to be installed, designed to afford information, after prolonged observation, on two distinct but interrelated lines of inquiry: The first relates to the relative load transference efficiency of the several joint types and the second to the effect of expansion joint spacing upon joint movements and behavior in service.

Of the joints selected for test, type one (Fig. 2) is a standard doweled design which serves as a control. Type two employs a thickened edge with no dowelling. Types three and four have a continuous support beneath the joints proper, which functions to facilitate load transference and also to seal, more or less effectively, the joints against infiltration of surface water. Type five involves a system of creosoted timber sills. Of types two to five, two of each are put in, with reinforcing bars omitted from one of each type.

Normally the expansion joint spacing is 495 ft., with construction joints between and 15 ft. apart; all concrete is plain and joint types 2 to 5 are to be used as directed. The exceptions are: Between Sta. 65 + 03 and Sta. 85 + 00, plain concrete, joint type 1 is used for two 30-ft., two 60-ft., two 120-ft., two 240-ft. and two 495-ft. spacings with contraction joints 15 ft. apart, and between Sta. 27 + 25 and Sta. 37 + 15, mesh-reinforced concrete, joint type 1 is used for two 495-ft. spacings with no contraction joints.

In planning these tests, the program was based on the belief that the principal desiderata in expansion-joint design are (1) load transference efficiency, (2) watertightness and (3) reasonable freedom of movement. Absolute freedom is not required, as a certain amount of compression is desirable to check the "growth" or gradual enlargement of intermediate contraction joints and cracks. Watertightness is necessary to eliminate the possibility of subgrade volume change due to the infiltration of water at joints; finally, load transference efficiency is essential to prevent both elastic and permanent joint displacements under traffic.

It is believed that the joint types selected possess these desirable qualities in varying degrees. Hence the program of observation includes extensometer measurements of elastic displacement under varying test loads and also a program of continued observations under service to determine the amount of permanent joint deformation and the degree to which such deformation increases with age.

A second phase of the investigation contemplates a study of certain factors affecting expansion-joint movement. That these are somewhat interrelated and involved may be appreciated by the consideration of the following rather elementary theoretical deduction. Consider any pavement slab fitted with expansion joints, as indicated in Fig. 3 and let the line *a-a* represent the point of longitudinal fixity. This may or may not be at the center of the slab, depending upon conditions. Under the action of an "equivalent" maximum temperature rise of t_1 deg. F., the linear expansion of any infinitesimal element of length dx, whose abscissa measured from the joint is x (see Fig. 3) is given by the expression:

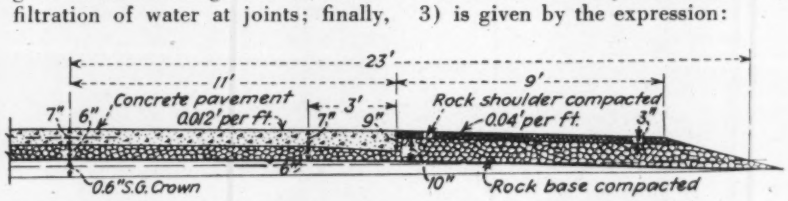

Fig. 1. Cross-section of concrete pavement used in expansion joint study.

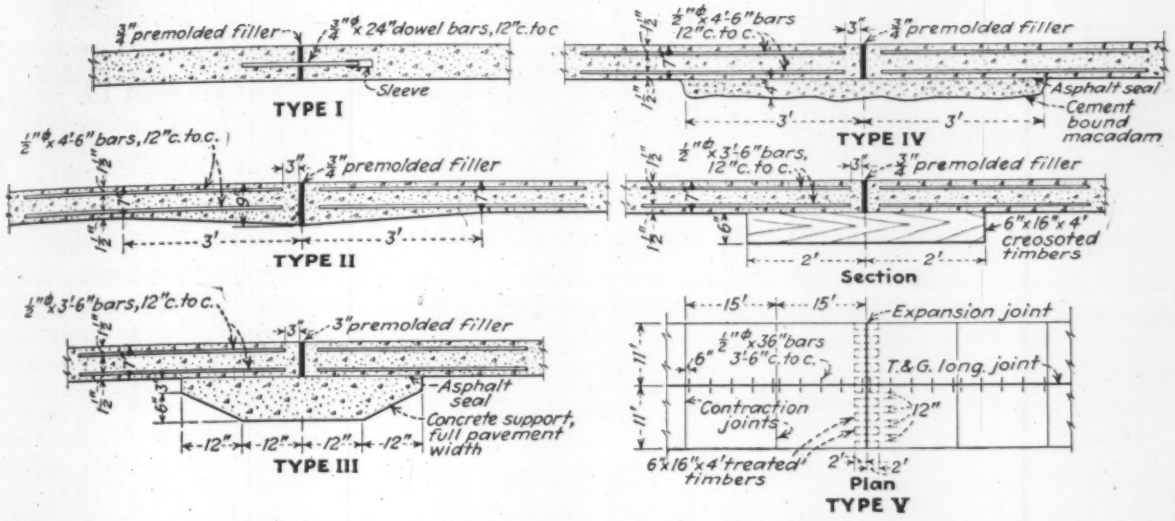

Fig. 2. Joint behavior of five different types of expansion joints, with spacings varying from 30 to 495 ft. and contraction joints on 15-ft. centers, is under observation.

$$\delta = ct_1 dx - f_0 dx/E - \phi w x dx/E \quad (1)$$

Where f_0 represents the unit joint compression; ϕ the frictional coefficient of the subgrade; and w the unit weight of the pavement. The total joint displacement is therefore:

$$\Delta = \int_0^L = \delta \int_0^L (ct_1 - f_0/E - \phi w x/E)dx \quad (2)$$

$$= ct_1 L - \frac{1}{E}\left[f_0 L + \frac{\phi w L^2}{2}\right]$$

An inspection of this formula indicates that the frictional resistance of the subgrade modifies the linear character of the relationship between Δ and L. In other words, the linear expansion of any length element, dx, is no longer independent of its distance from the joint. Equation 2 also indicates that joint movements will be affected by: (a) the coefficient of subgrade friction; (b) the maximum "equivalent" temperature rise; and (c) the unit compression transmitted through the expansion joint.

The term maximum equivalent temperature rise, as here used, refers to that rise in temperature which would produce the same linear expansion as would the combined effect of the maximum *actual* temperature rise and the accompanying variation in moisture content. This maximum equivalent temperature rise is largely a function of the locality. In certain sections, notably Oregon's Willamette Valley, maximum atmospheric temperatures are accompanied by low humidity and rainfall. Under such conditions, the expansion due to seasonal rise in temperature will be compensated in part by the contraction resulting from a decreased moisture content.

In other localities, the reverse is true, and high temperatures occur during those seasonal periods when the pavement is at or near maximum saturation. In any given case, therefore, it is necessary to determine the seasonal effect of both temperature and moisture variations, combining them to develop an effective or equivalent temperature rise of t_1 deg. F. to be used as a basis for theoretical comparisons.

These are only a few of the uncertainties involved; among the others are the "growth" or gradual enlargement of contraction joints, and transverse cracks. Plastic flow also enters the picture to modify theoretical results, as do the longitudinal tractive forces induced by live loads in motion and the infiltration of joint water with consequent modification of subgrade resistance. It is impossible within the limits of the project now under way to attempt a correlation of these many divergent and conflicting factors; however, the following determinations

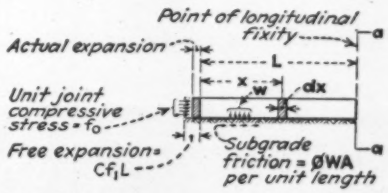

Fig. 3. Sketch showing elements used in the equation by which joint displacement is computed.

are programmed for future study:

1. Micrometer measurements over a period of years to determine seasonal joint movements and all plastic or permanent horizontal joint deformations.

2. The determination of daily, monthly and yearly changes in length of freely-supported control slabs cast at or near the site in order to evaluate the "equivalent" or effective maximum temperature variation, t_1.

Premolded filler type contraction joints of ¼x2-in. section, spaced 15 ft. on centers are used throughout the test pavement except on the two sections between Stations 27 + 25 and 37 + 15 which are to be reinforced, as indicated.

Micrometer measurements will be made throughout the tests to indicate any movement at the contraction joints, and in the attempted correlation between theoretical and observed joint displacements these intermediate movements will be taken into consideration.

Because of the complexity of factors that affect expansion joint action, it is not expected that any close correlation between theoretical assumptions and observed conditions will obtain. It is felt, however, that a theoretical working hypothesis constitutes an efficient reference frame for field phenomena and that through attempted correlations of this character it will be possible to obtain a more intelligent working knowledge of the field factors affecting expansion-joint behavior.

An Old Softening Plant Goes Modern

E. L. FILBY

Black & Veatch, Consulting Engineers, Kansas City, Mo.

Contents in Brief—What has happened in three decades of water treatment practice is shown in the modernization program undertaken by Owensboro, Ky., in revamping a 1911 softening plant to meet present day requirements. Among other things, gravel-wall wells replaced sandrock wells, "high-rate" filters are used and mechanical equipment is installed for sludge removal.

WHEN THE Owensboro, Ky., softening plant was built three decades ago to treat well water, using lime slakers and wood fiber filters, it represented the last word in good practice. Today, after long service, the original plant and supply facilities are being revamped to meet the standards of a new era. It is of interest, therefore, to report on the changes which are being made in a plant of the vintage of 1911.

Among other things, sandrock wells yielding water with 345-ppm hardness have been replaced by gravel-wall wells, near the Ohio River bank, producing water carrying 50-ppm hardness. A splash-type aerator is employed to reduce the hydrogen-sulphide and carbon-dioxide content, and post-recarbonization will be used. A mechanical sludge collector is installed in the revamped settling basin and the designed rate of filtration is twice the normal, thus bringing to Kentucky the first "high-rate" filter in the state.

A public water supply has been in use at Owensboro since 1878 when a private company distributed untreated Ohio River water. In 1906 the people rebelled against the continued use of this unclean and often muddy product, and voted $260,000 to install a municipal system drawing water from thirteen 125-ft. wells driven to sandrock on the river bank. About this time the water company installed an infiltration gallery (*ENR*, Sept. 28, 1907) to improve the appearance of the water. Offering clear, cold, taste-free water, however, the city soon secured the domestic load, although industry continued to use the softer Ohio River supply. In 1911 a 3-mgd softening plant was constructed at a cost of $28,380 (*ENR*, June 1, 1912).

This plant included lime slaking tanks, four mixing basins fitted with sixteen motor-driven, paddle-type mixers and two settling basins, each of 324,000-gal. capacity (5-hr. retention). The basin bottoms "sloped upward at a 30-deg. angle to the horizontal to provide for efficient sedimentation," and the coagulated water was admitted by downdraft pipes to within 5 ft. of the deepest part of the basin. Sludge was removed through an underdrain system built in the floor of the basin and the water filtered through wood-fiber filters in an iron manger placed along the outlet side of each basin to "remove after-deposits." The steam-operated plunger wells in the pump station had been augmented by an airlift system of wells drilled into the sandrock. The water was softened from 15.4 gr. to 3.87 gr. per gallon and the private water company soon abandoned its competitive operations.

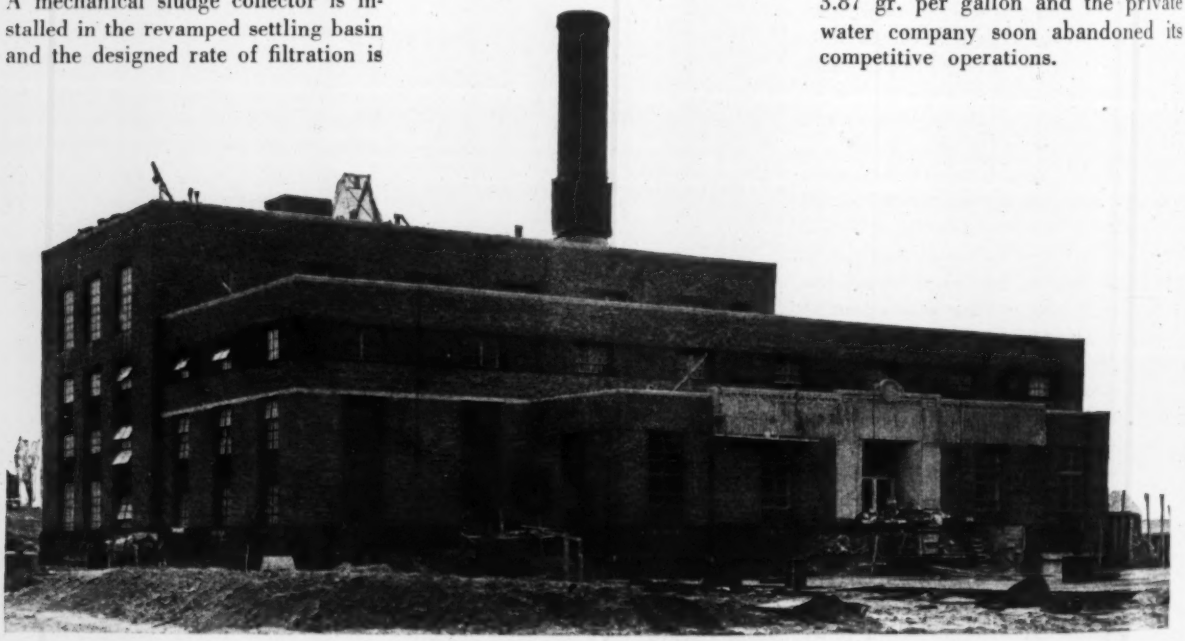

Fig. 1. Combination water treatment and electric power generation plant recently completed for Owensboro, Ky.

From 1912 to 1938 practically no changes in operation were made although a recarbonation system was installed and later "abandoned because of noise." When a well failed a new one would be constructed a few feet distant. Electric turbine-type pumps replaced the airlift wells and electric high-service pumping was added, but the steam plant was retained because of fire protection demands and to supply the eleven "steam-head" wells in the pump station.

In 1938 a $2,313,370 PWA construction program of rehabilitation of the municipal water and light utilities was inaugurated with $600,000 allotted to the improvements to the water utility.

New well supply

It was determined that wells located near the river bank produced a water softer by 200 ppm than that from the "steam-head" wells, and with modern construction the yield could be increased and operating costs reduced. Accordingly three gravel-wall wells, each 125 ft. in depth and 18 in. in diameter, underreamed to 36 in. in the water sand formation and packed with fine gravel, were constructed.

The screens, of bronze composition, are of shutter-type construction, 10 in. I.D. and 21 ft. long. Each well has a drawdown measuring tube and a discharge meter. The wells are 525 and 800 ft. apart, and will yield 1,000 gpm, although they are rated at 750 gpm each. As the water-bearing sand is very fine, high pumping rates are not recommended. The three wells cost $24,137, including connecting piping and will replace eleven "steam-head" wells and seven electric-operated plunger-type wells; they will yield 27 per cent more water and the hardness is only 8.5 gr. as compared with the previous 20 gr. hardness.

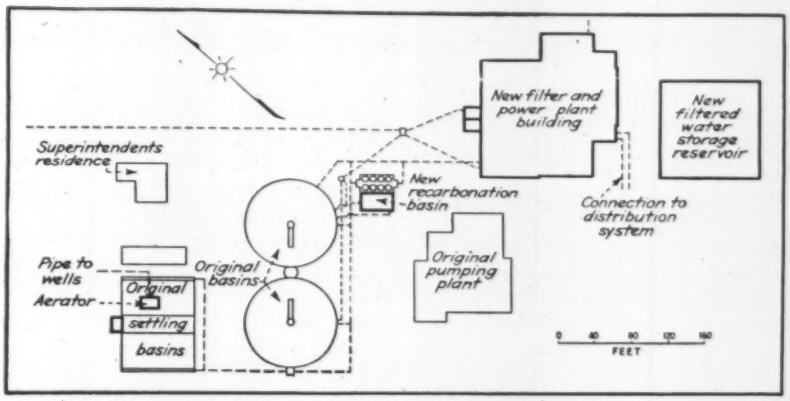

Fig. 2. General layout of the water treatment facilities which are built around former plant units.

In connection with the combined power plant construction a $250,000 intake is being constructed in the Ohio River to supply condenser water. By minor changes this water can be made available as a source of raw water for domestic or industrial use.

Treatment works modernized

In planning to soften the well water every effort was made to minimize costs, and all existing structures except the pumping station were incorporated in the rehabilitation program. The discharge from the various wells is gathered in a common header at the old softening plant and discharged over a redwood splash-type aerator for the reduction of hydrogen-sulphide and carbon-dioxide. From the aerator the water flows over a 6¼-ft. measuring weir equipped with indicating and totalizing mechanism.

Lime sludge from the settling basins is added to the old No. 1 mixing unit and the heavier sludge is withdrawn from the old No. 2 unit. Freshly-slaked lime solution is added as the treated water enters the remaining mixing units. The existing distributing flumes are continued in use, but the "downdraft" tubes have been omitted pending preliminary testing. Each settling basin has been reconstructed with a new bottom and a 14x75-ft. mechanical sludge collector of the straight-line type. A slat baffle tends to concentrate the deposition of sludge over the collectors. Adjustable weirs are available to regulate the basin overflow, and the inlet ports have adjustable metal covers to equalize distribution into the basin. A sludge control pit, 17x10 ft. in plan, has been added at the north end of the mixing basins of the old softening plant. Some of these changes are illustrated in Fig. 3.

The treated water is piped to the existing westerly covered reservoir, 100 ft. in diameter and 17 ft. deep, which has been fitted with center inlet and peripheral weir for further settling. From this basin the water enters a two-pass recarbonation basin, 34x8½x15 ft., where carbon dioxide gas extracted from natural gas is added through sixteen 3-in. porous diffuser tubes, each 2 ft. long. The carbon dioxide compressors are in duplicate to provide for post-recarbonation; the latter procedure will be used for several years to remove excessive lime deposits in the distribution system. Post-recarbonation is effected through diffuser tubes installed in a special bypass manhole at the entrance to the pump suction

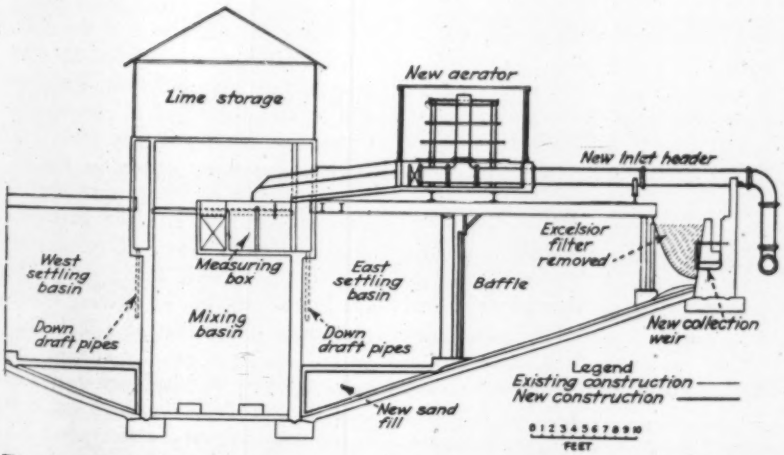

Fig. 3. How the softening plant structures were revamped to meet the new design.

well. All tubes are readily removable for cleaning. Following recarbonation, sludge from the final settling tank is added in a dual mixing chamber where a small amount of alum is also added to aid in settling.

The existing easterly reservoir, 100 ft. in diameter by 16 ft. in depth, has been converted into a radial-flow settling basin, and fitted with a section-type sludge-collecting mechanism. Sludge may be wasted or recirculated. Yard piping is provided to permit the bypassing of any unit of the preliminary treatment works.

The water is filtered through three filter units of the conventional perforated-pipe underdrain type with 20x18 ft. of sand surface. Eighteen inches of gravel and 24 in. of sand are provided, but all piping is designed and the plant will be operated at 4 gal. per sq.ft. per min. Rate controllers and hydraulic valves are provided on each of the three filter units. Washwater is stored in a steel tank, 28 ft. in diameter by 16 ft. in depth, located above the filters. A high-pressure pipeline has connections for surface wash by jetting. The pipe gallery is so designed that three additional filter units may be added west of the new units in the event that the well field fails and river water must be used, and in consequence the filtration rate must be cut below the 4-gal. rate.

The plant effluent will be chlorinated, and a special feeder will permit the use of hexametaphosphate ("Threshold treatment") in case of carbon dioxide failure. A fully equipped chemical and bacteriological laboratory is air-conditioned. A remote water-level indicator and alarm system are installed in the pumproom to show the water level in the elevated tank at all times.

The new high-service pumps, arranged for direct suction from the pump well, consist of three electrically-driven units of 3.5, 3.5 and 4.5-mgd capacity and one steam-turbine-driven fire pump of 10-mgd capacity for emergency use. A small washwater pump is provided. Water used for air conditioning is returned to the clear well in a closed pipe system to prevent any cross-connection.

The general contractor on the building which will house the water filtration plant, pumping room, turbo-generators, boilers, repair shops and offices is Engstrom & Wynn, of Wheeling, W. Va. The filter equipment contract was awarded to the Municipal Service Co. of Kansas City. The Layne-Central Co. installed the gravel-wall wells. The total water project will cost $600,000 while the electric project will total $1,700,000.

The entire project, including report, design, and supervision of construction has been handled by the office of Black & Veatch, consulting engineers, Kansas City, Mo., and operations began shortly after the first of the year.

Pile Bearing Increased by Close Driving

W. Z. LIDICKER

Engineer in Charge, Design Section
U. S. Engineer office, St. Paul, Minn.

***Contents in Brief**—Test of close driving on pile bearing capacity. Pile spacing of 3 ft. increased load 60 per cent. Supplementary tests indicate effect of earth surcharge in increasing bearing power of lower layer in which piles are footed.*

UNCOMMON pile bearing values were determined in a series of pile-loading tests conducted during the construction of Dam 3, near Red Wing, Minn., of the upper Mississippi River navigation works. Two sets of tests were made, each for a different underground condition actually existing in the foundation work. In one case wood piles were driven in sand; the tests were made to determine the effect on bearing power of compaction due to contiguously driven piles. At 3-ft. spacing an increase of 60 per cent was indicated. In the second set of tests, steel H-section piles were driven through a sand layer overlying a layer of silt, both assumed to provide no load resistance, to determine the penetration into a lower layer of sand that was required to withstand a design loading. These tests indicated a decided increase in resistance of the lower sand layer due to the surcharge load of the silt and sand layers above it. The details of the two tests follow.

Timber pile test procedure

Timber piles are used in a section of the dam founded on medium river sand, the upper portion of which had been recently placed by hydraulic methods giving a very uniform material. These piles support a roller gate section of the dam so that very little settlement could be tolerated. In the test area enough piles had to be driven to create the same effect that close driving in the structure would cause. The pile plan shown by Fig. 1 was selected, giving 54 test piles located in the apron section of the dam where the final structure loading was light but where they could be used as permanent piling to reduce the extra cost of the tests. Pile driving was scheduled to give information on different spacings and to note the effect of compaction caused by driving nearby piles.

The piles were driven in the sequence shown by the upper circled numbers of Fig. 1. The first pile driven (No. 1) was a 35-ft. selected load-test pile and, being driven in the loose material, its driving resistance represented that of a 35-ft. pile driven in loose sand. The second pile, a 40-ft. selected test-load pile No. 2, was driven a sufficient distance away so that it also represented driving conditions in loose sand.

Pile No. 3, a 30-ft. pile, likewise was driven a sufficient distance away from either of the others to represent driving in loose sand. Next, piles Nos. 4 to 41 were driven at the spacings indicated to compact the sand. Spaces were left for piles Nos. 42, 43 and 44 in the middle of the test area; therefore, when these piles were driven they represented driving in sand compacted by the driving of the surrounding piles.

Results of timber pile tests

The lower circled number at each pile in Fig. 1 shows the indicated bearing value computed from the *Engineering News* formula with the averages by rows shown below. Thus the indicated bearing value obtained by driving 30-ft. piles in loose sand is given in general by the average for the first row driven, namely, 9.7 tons for row *C*. Although all piles in this row, after the first, were affected somewhat by the piles previously driven, each pile was driven on the edge of the affected area and thus represents driving in what may be regarded as uncompacted soil.

The average indicated bearing value for row *D*, the next row driven, indicates a 49 per cent rise in bearing value caused by driving (hence compaction) the first row. The fact that row *E* shows only a slight increase in average bearing value over *D* and rows *F* and *G* show no increase, indicates that with 30-ft. piles little compaction occurs beyond 6 ft. and hence there is only a slight effect on indicated bearing values due to the driving of piles other than in the adjacent rows.

With these results indicating that the compaction obtained by driving substantially increases the indicated bearing value, load tests 1, 2 and 3 were undertaken to verify the driving data and in the case of load tests 1 and 2 to determine whether a 35-ft. pile driven into loose sand, which is later compacted around it by subsequent driving, would carry more than a 35-ft. pile driven into sand which had already been compacted by driving around the area. All test piles were carefully chosen for uniformity of specie, diameter and smoothness. The loads were applied to the piles by a hydraulic jack which thrust upward against a steel frame in the shape of an *H*. Each corner of the *H* was fastened to an anchor pile thus spreading the uplift force to four piles, each two rows away from the pile loaded. Loads were applied in increments up to 30 tons in about 3 hr., held for about 6 hr. and then released gradually. Then loads up to 60 tons were applied in increments over about 3 hr., held about 6 or 7 hr. and released gradually.

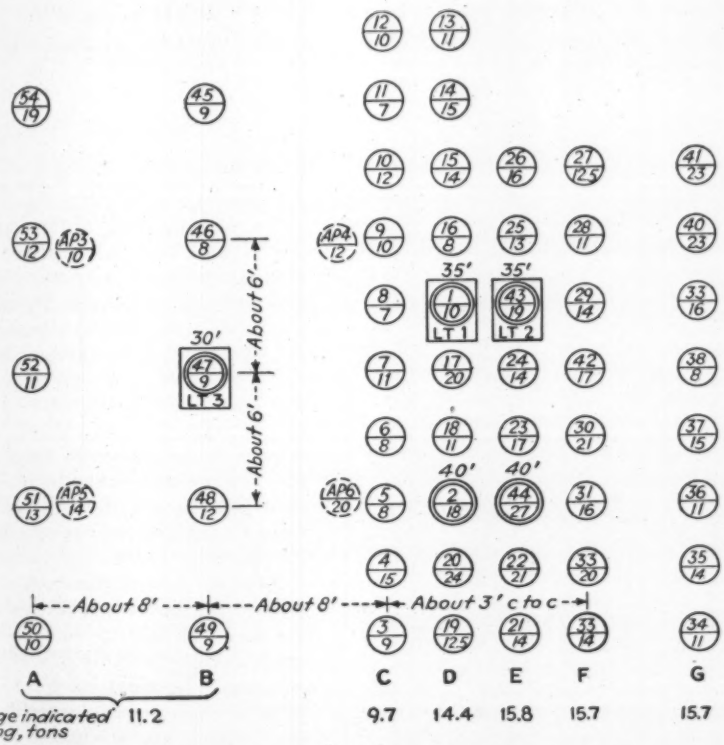

Fig. 1. Arrangement of piles to test effect of compaction due to close driving on the bearing value. Top circled numbers show sequence of driving, lower show bearing power indicated by the *Engineering News* formula. All piles are driven to 30-ft. penetration except 1 and 43 which are 35 ft. long and 2 and 44 which are 40 ft. long. Symbols LT indicate load test; AP3, AP4, AP5 and AP6 are anchor piles for the load test on pile 47.

The results of the tests are as follows: Pile No. 1 carried a load of 30 tons with a settlement of 0.12 in. and resisted a maximum load of 40 tons before partial failure. Pile No. 43 settled 0.08 in. with a load of 30 tons and resisted a maximum load of 60 tons before partial failure. The load test on pile 47, a 30-ft. pile in loose sand, resulted in a settlement of 0.22 in. at a 30-ton load and a maximum load of 35 tons before partial failure. Partial failure is taken as the point at which the rate of settlement increased rapidly.

From the tests made and for the material involved it appears that the compaction obtained by driving 30-ft. piles at close (3-ft.) spacing in loose sand raised the indicated bearing value about 60 per cent. The ratio between *Engineering News* formula bearing values and maximum load under test is fairly constant and for the three tests that were made averaged 1 to 3.7.

Many driving tests and load tests on locks and dams in the Upper Mississippi River have thrown doubt on the value of test piledriving as an indication of actual bearing capacity or length of piles required. It is believed, however, that factors such as variation in foundation material, in size and smoothness of piling and in varying percentages of silt or clay in the sand, which often affect pile studies, are largely absent in these tests.

Steel bearing pile tests

A section of the roller gate dam is over an area which has about 50 ft. of medium sand overlying a 10 to 15-ft. layer of silt as shown in section by Fig. 2. Due to the expected settlement of the silt layer with any increase in load over the original

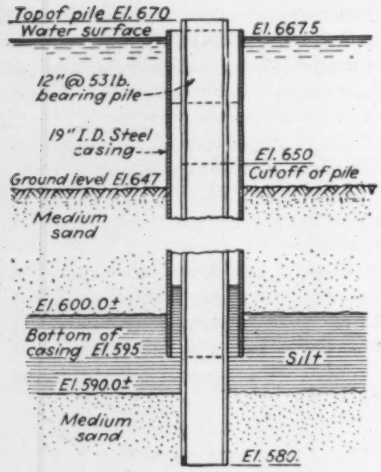

Fig. 2. Steel bearing pile driven within casing to confine bearing resistance to lower sand layer in which pile is footed.

conditions, it was not logical to assign any value in bearing to the length of steel pile in the sand above the silt. It was necessary to determine what length of penetration below the silt was required to sustain the design load of 30 to 40 tons for normal conditions and 45 to 50 tons for extreme and temporary conditions. A penetration of 10 or 15 ft. into the sand below the silt was believed sufficient to carry the load, and the test was planned on that basis. Long timber piles were not desirable as experience has shown that timber piles driven through a relatively soft stratum into a harder stratum are subject to breakage. Steel bearing piles 12 in. by 53 lb. were selected for use in this area.

Since any individual test pile would reflect the sustaining power of the sand above the silt, especially for short periods of time, it was necessary in the test to remove this effect. A 19-in. inside diameter steel pipe casing $\frac{3}{8}$ in. thick was driven through the upper sand layer well into the silt layer and the material inside removed as shown in Fig. 2. To prevent whipping and loss of impact force due to the long column involved, the test pile was supported laterally inside the steel casing by greased timber guides at 15-ft. spacings. A similar pile, without the casing, was put down about 15 ft. away to correlate the driving data from the test pile to all other permanent piledriving which, of course, was done without a casing. Protruding plates or cleats to increase the bearing value of the pile were not used.

Test methods and results

The test piles were loaded simultaneously by two 100-ton hydraulic jacks thrusting upwards against a weighted box supported on short timber piling. Two series of loadings were used: the first up to 48 tons applied over a period of 6 hr. held for 20 hr. and released over 4 hr.; the second up to 96 tons applied over a period of 20 hr., held for 17 hr. and released over 6 hr.

The pile tests resulted in a settlement of 0.25 in. at 92 tons for the pile without the casing and a settlement of 0.25 in. at 74 tons for the pile within the casing. The load settlement curves for the latter pile are shown by Fig. 3. With a correction made for the shortening of the pile within the casing down to the sand layer, the settlement of the bottom 10 ft. of the pile at a 96-ton load is found to be only 0.10 in. as shown by Fig. 3.

In view of the driving data the load-carrying ability of the pile within the casing is particularly surprising. Based on the *Engineering News* formula, the indicated safe bearing load for this pile is only 10 tons. Yet an actual load of 96 tons was held for 17 hr. with negligible settlement. The reason, of course, for the unusually high load-carrying capacity of a relatively short pile penetration is that a surcharge of about 57 ft. of fill acted on the material surrounding the pile. After the cessation of driving, the readjustment of the surcharge load took place by flow within the silt layer, and by the time the load test took place a week later the full effect of the pressure of 57 ft. of sand and silt was apparent.

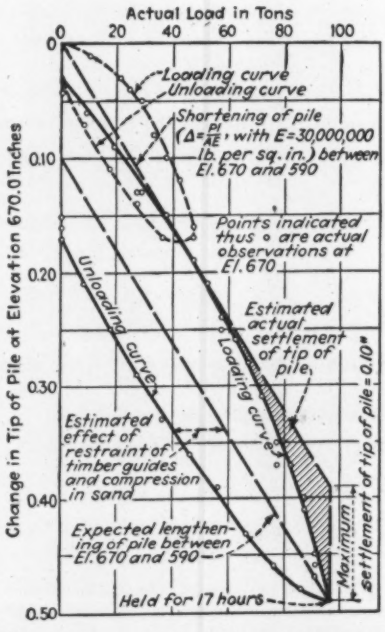
Actual Load in Tons
0
20
40
60
80
100
0
0.10
0.20
0.30
0.40
0.50
Change in Tip of Pile at Elevation 670.0 Inches
Loading curve
Unloading curve
Shortening of pile ($\Delta = \frac{Pl}{AE}$, with E=30,000,000 lb. per sq. in.) between El. 670 and 590
Points indicated thus ∘ are actual observations at El. 670
Estimated actual settlement of tip of pile
Unloading curve
Loading curve
Estimated effect of restraint of timber guides and compression in sand
Expected lengthening of pile between El. 670 and 590
Held for 17 hours
Maximum settlement of tip of pile = 0.10"

Fig. 3. Load settlement curve for steel pile within casing. Only lower 10 ft. of the long pile is actually supported in the footing layer of sand.

Timber and steel piles designed in accord with the above tests have supported the dam with a settlement about in conformity with the test results.

The dam was constructed by A. Guthrie & Co., Inc., contractors, under the supervision of the U. S. Engineer Department, St. Paul, Minn. Lt. Col. Dwight F. Johns was district engineer, at that time, W. D. Fairchild was resident engineer and the writer was in charge of design. Conclusions drawn in this article should be understood to be those of the author and are not to be construed as necessarily representing the views of the U. S. Engineer Department.

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British Building Research

A systematic study of the problems of the building industry has been undertaken by the Institute of British Architects. A committee has already prepared a program for research and the methods by which the program can be carried out, and a research board has been appointed to put the project into operation. The program covers certain aspects of rural building requirements, urban housing, materials, cost accounting, legal and building regulations, town and country planning, health, recreation, and unification and standardization. It is planned to cover unexplored fields and to deal with broad principles rather than with the details of actual buildings. In addition, an architectural science committee will study and report on scientific developments that are applicable to building work. Under many of the divisions of the program considerable research has been done already, but needs collecting and correlating of the information.

FROM FIELD AND OFFICE

Working problems and time-saving methods for engineers and contractors

Welded Pipe Trestle Bents

Much of the support for belt conveyors at the Friant Dam gravel plant is old iron pipe brought to the job in assorted lengths and diameters and there welded up into bents or towers to suit the requirements. The

Used pipe, welded into bents, provides inexpensive support for conveyor belts.

bents are stiff enough so that even when quite long they can be fabricated on the ground and then lifted bodily to place by crane or ginpole. They are free from fire hazard, erection time was short and the cost was very low.

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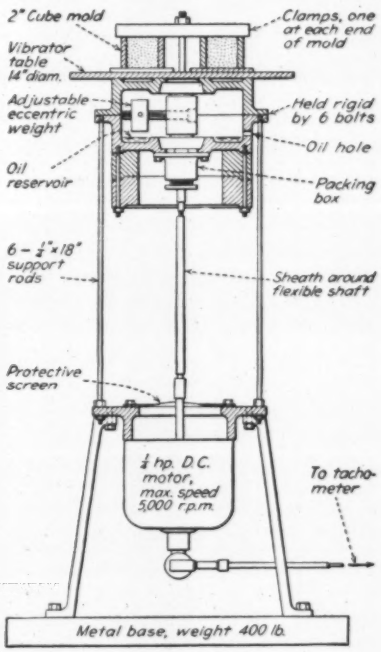
Vibrator for Mortar Tests

A new vibrator developed by the National Bureau of Standards and illustrated here has proved of considerable advantage in the preparation of mortar specimens for compression tests. Mortar test specimens are in the form of 2-in. cubes, and the standard procedure for years has been to use a wet mix and to thumb the mortar into the mold. The human element is, naturally, an important factor in the results. The new plan employs a vibrating table on which


2" Cube mold
Clamps, one at each end of mold
Vibrator table 14" diam.
Adjustable eccentric weight
Held rigid by 6 bolts
Oil hole
Oil reservoir
Packing box
6 – ¼" x 18" support rods
Sheath around flexible shaft
Protective screen
¼ hp. D.C. motor, max. speed 5,000 r.p.m.
To tachometer
Metal base, weight 400 lb.

Vibrator for compacting mortar test specimens developed by the U. S. Bureau of Standards.

the mold is securely fastened. The mortar is poured into the mold and compacted by the motion of the machine which, being mechanical and uniform, eliminates the variables of the old method.

In tests conducted at the bureau, two vibrators were used. One is a commercial magnetic barrel-packer vibrator, having a fixed frequency of twice the frequency of the supply current; the other is a Tucker's mechanical vibrator which produces horizontal rotary motion. It was found that the best results were obtained with the rotary vibrator operating at 83 cycles per second.

Standard Ottawa-sand mortars were at least as satisfactory for compaction by vibration as any of the other mortars tested, but they had to be very dry. The reproducibility of batches was found best in 1: 3½ and 1: 4 standard Ottawa-sand mortars with water constants of 9.5 and 10 per cent. The 7-day strength of these mortars was about 3,000 lb. per sq.in. The vibration of the mortar into the standard test specimens gave more reproducible results than were obtained from hand-compacted specimens.

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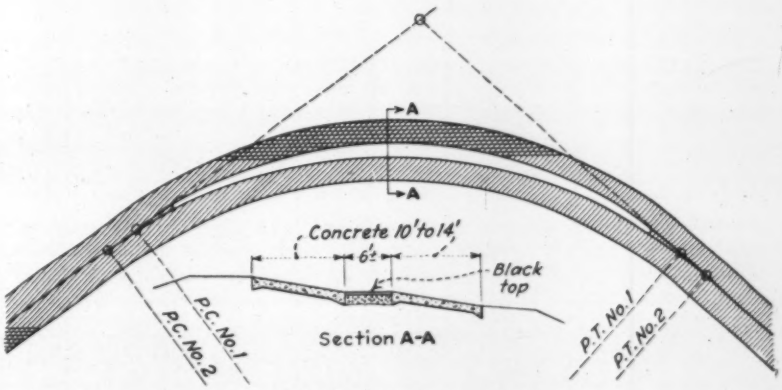
Safe Sharp Curve

E. L. STEWART
Brady, Neb.

The accompanying sketch shows a curve layout which, I feel, will cut down accidents on small-radius curves. Being a highway engineer, I know, of course, that small-radius curves are objectionable, but due to conditions it is often necessary to employ them, as at overhead or underpass grade crossings. The sketch shows a 20-ft. pavement, with no additional widening of the individual curves, but I feel that these should be widened from 2½ to 4 ft. starting the widening about 250 ft. on each side of the P.C. and P.T. The parting strip is shown filled level with gravel and black top; this strip, of course, can be filled with any solid material, and would be better if crowned instead of flat, as this would keep the driver on his side and prevent passing.



Divided roadway increases safety of short curves.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

SUPERNATANT LIQUOR — The deleterious effect of digestor supernatant liquor on bulking of activated sludge has been reported on many occasions. As a rule when the activated sludge is in good condition a considerable quantity of digestor liquor can be handled, but when the sludge is unstable, even small amounts are sufficient to upset such sensitive sludge with resultant bulking. Berg (*Proceedings*, 21st Texas Water and Sewage Short School, 1939) on the basis of extended experimentation at San Antonio, believes that there is a lasting poisoning effect on activated sludge by the digestor supernatant liquor. Over a long period of operation when a heavy load of liquor was reduced it required some months before the sludge index dropped and then only after a decided increase in air was supplied. This "poisoning" effect would seem to be related directly to the avidity for oxygen of the soluble and semi-soluble materials present in the liquor. Berg contends that a B.O.D. load of 1,000 lb. digestor overflow is far greater than 1,000 lb. B.O.D. of raw sewage. If it is correct that the avidity for oxygen of the digestor liquor is greater, the available type and quantity of food would cause an oxygen demand which could not be assimulated by the sludge without deterioration.

WAR AND SEWAGE TREATMENT—Many of us have wondered what war means to sewage treatment. A terse and graphic description given by Abbott (Shanghai Public Works Report for 1939) indicates what may happen. He says:

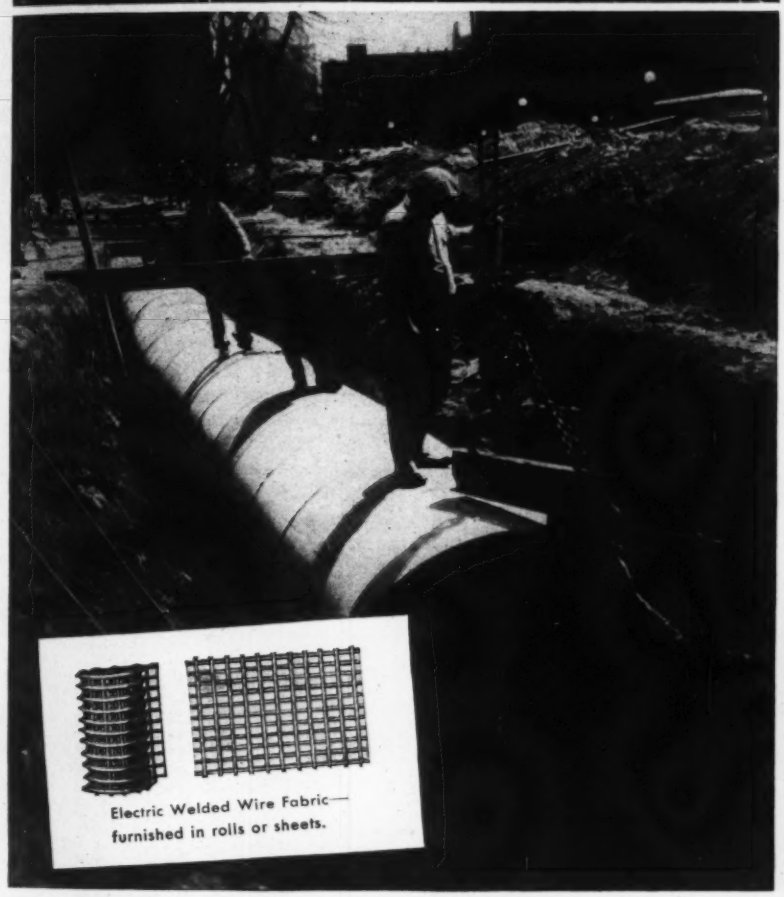
"The Western Treatment Works was closed under *force majeure* at the end of October, 1937. Early in 1938 it became possible to resume maintenance and to repair the war damage. Conditions in the neighborhood were such that operation would have been very difficult, if not actually impossible. Early in 1939 conditions had improved considerably and permission was received to resume treatment. In March sewage was diverted intermittently to the Works in order to prepare a new activated sludge. On May 10, the full flow of sewage was diverted to the Works, since when 644,980,000 imperial gallons have been treated. It was found that the flow and strength of the sewage had increased to such an extent that the quantity of polluting matter was rather more than double the 1936 figure. This meant that the Works was under a substantial overload and that the previous operating practice could not be resumed.

"Several experimental operating cycles were tried to determine the means of obtaining the utmost possible degree of purification with the existing equipment. When found, this routine was adhered to as far as circumstances permitted. These circumstances were often trying and sometimes disastrous. For instance, in July the power supply to the Works failed for many hours on seven occasions owing to the theft of power company cable during the night. Passes for the staff were a recurring source of worry and on occasions the laboratory could not be staffed. Sludge disposal suffered from the impossibility of securing suitable qualities of sand. At times the sewage strength was considerably increased by partial failure in ordure disposal and the consequent admission of ordure into the sewers."

GRAPEFRUIT CANNING — The problem of treatment of wastes from grapefruit canning plants is confronted in Texas, Florida and California. The citrus wastes from canning plants are strong with a B.O.D. varying from 400 to 4,000 ppm, but the waste from the dehydration plants are far worse from a pollution standpoint since this has B.O.D. values of from 8,000 to 80,000 ppm. Ratliff (*Proceedings*, 21st Texas Water and Sewage Short School, 1939) describes experiments on a plant scale utilizing chemical treatment and the results from an experimental treatment plant. The dehydration wastes, including oils and sugars pressed from grapefruit peel are usually insufficiently diluted for treatment by customary sewage treatment devices. After treatment with alum, lime and activated carbon the waste was settled and discharged into a 48-ft.-long trough-like aerator. Aeration was produced by passing the effluent over and under a series of baffles set across the trough at 6-in. centers, obtaining a contact time of about 30 seconds. The aerated effluent was then chlorinated, mixed with sewage and passed to the municipal sewage treatment plant. Other studies were made on the effect of filtration through sand, gravel and rock. With coagulation, settling, aeration, dilution and chlorination the B.O.D. was reduced by about 70 per cent. By filtration of the continuous flow type a further reduction of 30 to 45 per cent of the remaining B.O.D. took place.

HEATING SLUDGE—In this country chemicals are used exclusively for conditioning of sludge. Claims are made abroad that heat treatment for half an hour at a pressure of about 150 lb., is an excellent method of sludge conditioning, and in many ways superior to chemical means. Sludge so treated can be dewatered readily, producing a relatively dry cake. An objection to utilization of the heat process is the quantity of hot press liquor. Jenkins (*The Surveyor*, Dec. 15, 1939) believes that before the method can be generally adopted a means must be found of treating this liquor because it is highly pollutional. A man named Porteous, holding the patents for the heat treatment process, states that as the process is carried out at high temperatures the liquor separating from the sludge containing considerable quantities of soluble matter which would not be dissolved in cold liquor, is sterile. Although the liquor has a high oxygen consuming value when returned to the sewage, oxidation is more rapid and no detrimental effects are apparent. If necessary the liquor can be treated easily and cheaply before returning, which he believes is more difficult with digestor supernatant. Supernatant liquor contains large numbers of anaerobic bacteria and is not as easily oxidized as the sterilized liquor. The sterilized liquor appears to aid coagulation of suspended matter.

Wire Fabric Reinforcement adds STRENGTH to Concrete Pipe



Electric Welded Wire Fabric—furnished in rolls or sheets.

● WHEREVER the use of Concrete Pipe is indicated, low first cost, low installation cost and durability can be assured by reinforcing with Wire Fabric.

For this purpose—years of experience have proved the outstanding value of American Steel & Wire Company's Wire Fabric Reinforcement.

Its ability to aid in load distribution and to withstand heavy stress makes it first choice for strength, economy, efficiency and durability.

Our Electric Welded Wire Fabric is made to recognized standards. Let our engineers consult with you on your requirements, as to spacings, gauges, size rolls, or sheets. We invite you to write for information on this product and the service that stands behind it.

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Columbia Steel Company, San Francisco, *Pacific Coast Distributors* United States Steel Export Company, New York

UNITED STATES STEEL

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

COTTAGE GROVE DAM
OREGON

OWNER: U. S. Engineer Office, Portland, Ore.; Major C. R. Moore, division engineer.

PROJECT: Construction of Cottage Grove Dam and appurtenant works, an earth fill structure for flood control, located on Coast Fork of Willamette River, Lane County, Ore., near Cottage Grove. Work involves diversion and care of river and local drainage during construction period; excavation for spillway and outlet structure foundations; construction of concrete spillway and outlet structure consisting of free overflow gravity section, reinforced concrete wing walls to retain earth embankment at west end of spillway, outlet openings at base of spillway, outlet valves or control gates, reinforced concrete spillway apron; earth dam embankment complete; access roads; steel bridge; road to adit; and surfaced roadway on earth dam section. An absorptive type of fibrous form lining is to be used on concrete surfaces which are subject to wear or weathering. Tests to be made by contractor of all proposed linings before acceptance by contracting officer or engineer.

CONDITIONS: Government to furnish cement for structure; contractor to furnish all other materials. Railway facilities to about 6 miles for site of work, and highway passes dam site. Work to be completed within 540 calendar days. Wages are: skilled $1.10 to $1.50 per hr.; semi-skilled, 75c. to $1.00; and common labor, 62½ and 65c. per hour. A lumber flume parallels the Coast Fork of Willamette River and crosses axis of dam. Contractor is therefore required to schedule his work so there will be no interference with flume operation until notified of its abandonment which will be about 90 days after commencement of work.

BIDS: Thirteen bids were received June 14, 1940, ranging from the contract low of $769,930 to $1,125,515.

LIST OF BIDDERS:

1. T. E. Connolly, Inc., San Francisco, Calif. $769,930
2. Goetz & Brennan, and C. L. Creelman, Seattle, Wash. 791,350
3. J. A. Terteling & Sons, Boise, Idaho 884,700
4. A. Teichert & Son, Inc., Sacramento, Calif. 911,885
5. Utah Constr. Co., San Francisco, Calif. 912,975
6. Morrison-Knudsen Co., Inc., Portland, Ore. 935,160
7. Parker-Schram Co., and Eaton & Smith, Portland, Ore. 935,935
8. W. E. Kier Constr. Co., San Diego, Calif. 974,555
9. L. H. Hoffman & McNutt Bros., Eugene, Ore. 985,980
10. Kuckenberg Constr. Co., and Strong & McDonald, Portland, Ore. 1,044,065
11. Winston Bros. Co., Minneapolis, Minn. 1,059,325
12. Natt McDougall Co., Portland, Ore. 1,098,310
13. General Construction Co., Seattle, Wash. 1,125,515

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Diversion, care of water	L.S.	$500.00	$22,000.00	$3,000.00
2. Strip. earth dam fdn. areas	23,000 c. y.	.10	.25	.12
3. Common excavation	160,000 c. y.	.24	.25	.30
4. Rock excavation	23,000 c. y.	1.33	1.00	2.00
5. Borrow excavation	710,000 c. y.	.14	.18	.17
6. Embankment, zones 1 and 3	440,000 c. y.	.02	.025	.02
7. Embankment, zone 2	230,000 c. y.	.06	.06	.03
8. Embankment, zones 4 and 5	60,000 c. y.	.005	.03	.02
9. Water for sluicing embk.	10,000 M c. f.	.50	.50	1.00
10. Add'l. rolling, 2 passes	100,000 sq.	.005	.01	.02
11. Backfill against conc. struc.	6,000 c. y.	1.00	.50	1.00
12. Dumped riprap on embk.	18,300 c. y.	1.00	1.75	1.50
13. Derrick placed revetment	3,500 c. y.	2.00	2.25	3.00
14. Haul and store cement	63,000 bbl.	.40	.15	.10
15. Class A concrete	6,800 c. y.	16.00	18.00	14.00
16. Class B concrete	15,000 c. y.	5.50	4.75	7.00
17. Class C concrete	4,000 c. y.	6.00	4.75	7.00
18. Fdn. grout holes, und. 25 ft.	1,500 l. f.	1.50	.25	1.00
19. Same, 25 to 50 ft.	3,000 l. f.	2.00	.40	1.50
20. Pressure grouting	4,000 c. f.	.70	1.00	1.50
21. Copper water stops	3,500 lb.	.40	.50	.50
22. Reinforcing steel	1,100,000 lb.	.042	.046	.0475
23. Struct. carbon steel	37,000 lb.	.10	.10	.10
24. Outlet gates (6)	L.S.	46,000.00	50,000.00	50,000.00
25. Miscellaneous metal	23,000 lb.	.16	.15	.13
26. Misc. pipe, fittings, valves	32,000 lb.	.20	.20	.15
27. Electrical work	L.S.	3,000.00	3,000.00	5,000.00
28. Adit entr. str., plumbing and sanitary sys.	L.S.	600.00	4,000.00	1,000.00
29. Uncl. highway excavation	19,500 c. y.	.70	.60	.50
30. Roadway surf., base course	900 c. y.	1.50	2.00	1.00
31. Roadway surf., top course	900 c. y.	1.70	2.30	1.00
32. Roadway surf., on earth dam	1,100 c. y.	.25	1.75	1.00
33. 18-in. corr. iron culv. pipe	70 l. f.	2.50	2.50	2.00
34. 24-in. corr. iron culv. pipe	100 l. f.	4.00	4.00	3.00
35. Roadway guard fence	100 l. f.	.80	.75	1.00
36. Right-of-way fence	300 rd.	5.00	2.50	2.50
37. Conc. in brdg. piers, Cl. A	100 c. y.	20.00	25.00	20.00
38. Struct. steel, bridge	70,000 lb.	.10	.09	.10
39. Bridge timber, untr.	4 M bm.	80.00	50.00	50.00
40. Bridge timber, treated	28 M bm.	120.00	90.00	80.00
41. Add'l foundation excav.	1,500 c. y.	.10	1.00	3.00
42. Asphalt for seals	12 ton	40.00	40.00	50.00
43. Sump pump and motor	L.S.	600.00	1,000.00	750.00
44. Drill and broaching	4,000 s. f.	.60	.20	.50
45. Drilling and grout anchors	2,200 l. f.	2.00	.25	1.00

SEWER SUBMAIN
LOUISVILLE, KENTUCKY

OWNER: Commissioners of Sewerage, City of Louisville, Ky.

PROJECT: Construction of Crittenden Drive-Maylawn Avenue submain in Louisville, Ky. Includes all excavation, concrete work, brick masonry, and paving. Alternates of penetration asphalt macadam paving, types A and B, or cold laid asphalt macadam paving were allowed. Contract awarded on the former.

CONDITIONS: Contractor to furnish all materials and complete work in 100 days. Rail and highway transportation facilities available. Wages are: skilled 85c. to $1.00 per hr.; semi-skilled labor, 65 to 75c. per hr.; and common labor, 40 to 50c. per hr.

BIDS: Three bids were received June 12, 1940, ranging from the contract low of $49,609 to $55,434.

LIST OF BIDDERS:

1. Columbia Constr. Co., Louisville, Ky. (contract) $49,609
2. Charles E. Cannell Co., Inc., Louisville, Ky. 53,959
3. W. L. Hailey & Co., Nashville, Tenn. 55,434

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Earth excav. and backfill	43.45 l. f.	$30.00	$32.50	$31.00
2. Earth excav. and backfill	603.86 l. f.	20.00	20.00	21.50
3. Earth excav. and backfill	1,083.69 l. f.	10.00	13.00	12.50
4. Earth excav. and conc. backfill	30 l. f.	35.00	47.00	50.00
5. Class A concrete	218 c. y.	22.00	24.00	25.00
6. Class A concrete	283 c. y.	23.00	25.00	27.50
7. Class A concrete	21 c. y.	40.00	35.00	25.00
8. Class A concrete	80 c. y.	40.00	38.00	35.00
9. Class C concrete	75 c. y.	20.00	18.00	15.00
10. Brick masonry	2 c. y.	30.00	25.00	35.00
11. Vitrified brick lining	40 s. y.	6.00	5.00	3.50
12. Steel reinforcing bars	57,000 lb.	.06	.06	.06
13. Earth excav. below sewer	75 c. y.	2.00	2.00	2.50
14. Gravel refill below sewer	75 c. y.	3.00	3.00	2.50
15. Clay sewer pipe ASTM (24 in. and smaller $1,205.40)	L.S.	602.16	602.16	752.70
16. Lay pipe, with cem. mortar 6 in.	163 l. f.	.30	.80	.35
17. Lay 8 in. pipe, with cem. mortar	10 l. f.	.30	.85	.35
18. Lay 10 in. pipe, with cem. mortar	12 l. f.	.30	.90	.40
19. Lay 12 in. pipe, with cem. mortar	70 l. f.	.40	.95	.50
20. Lay 15 in. pipe, with cem. mortar	100 l. f.	.50	1.00	.60
21. Lay 18 in. pipe, with cem. mortar	45 l. f.	.60	1.10	.75
22. Lay 21 in. pipe, with cem. mortar	40 l. f.	.80	1.20	1.00
23. Lay 24 in. pipe, with cem. mortar	35 l. f.	1.00	1.40	1.25
24. Lay 4 in. underdrain	1,000 l. f.	.50	.40	.30
25. Lay 6 in. underdrain	700 l. f.	.50	.60	.40
26. Pen. asph. mac. pavmt. "A"	390 s. y.	1.90	1.75	4.00
27. Pen. asph. mac. pavmt. "B"	530 s. y.	1.85	2.00	3.00
28. Cold laid asph. mac. pavmt. (Alt. with 26 and 27 above)	920 s. y.	2.00	1.75	3.00

For compacting earth fills—the practical design of Blaw-Knox Sheepsfoot TAMPING ROLLERS appeals to contractors because they give uninterrupted service and meet all modern specification requirements.

The roller units are full floating, on husky frames—built for long, hard use.

Send for complete details and prices.

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BLAW-KNOX
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TAMPING ROLLERS

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Bulletin 1606 entitled Blaw-Knox Buckets for Contractors shows how to select a bucket to secure the profitable difference between peak and ordinary performance—it will be sent on request.

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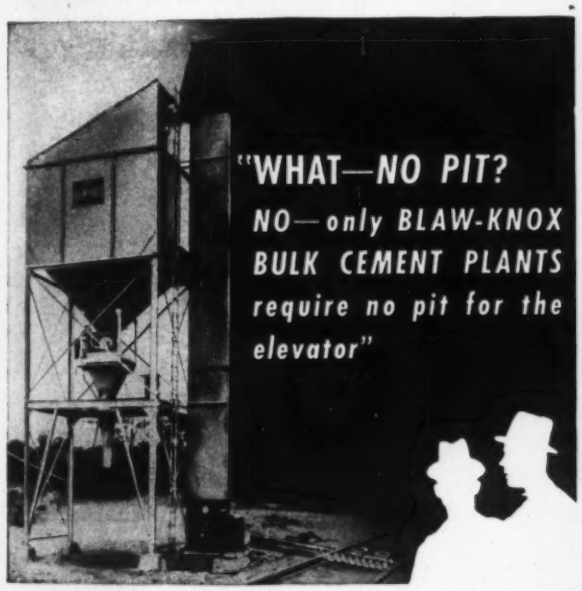
FARMER'S BANK BUILDING PITTSBURGH, PA.

BLAW-KNOX
REHANDLING BUCKETS



Blaw-Knox BULK CEMENT PLANTS are the ultimate in portability, speed, and convenience of use and operation. They are *complete units* for unloading, storage, batching and handling of bulk cement—dependable and accurate.

21 Completely described in Blaw-Knox Catalog No. 1566. Send for copy.

BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.
Bulk Cement Plants

SEVEN MATERIALS IN ONE BIN?
"You Bet—this new BLAW-KNOX plant accurately measures and loads aggregates, cement and water into truck mixers."

Blaw-Knox Truck Mixer Loading Plants include overhead storage bins for aggregates and cement; accurate Weighing Batchers for aggregates, cement and water; arranged for manual or automatic operation; complete conveyors for handling materials from cars or trucks to bins, when desired—all properly designed and built to your requirements as an efficient unit for truck mixer loading. See Blaw-Knox Catalog No. 1582 15

BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.
TRUCK MIXER
LOADING PLANTS

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LUMBER AND REINFORCING STEEL provide the most important price changes in the construction material market for August. Short Leaf Yellow Pine is up 50c. on all sizes in Atlanta; up $1.00 on 1-in. sizes in Kansas City. Pine and Spruce are $1.00 to $3.00 higher in Boston. Douglas Fir is up $2.00 to $3.00 in Boston; up 50c. to $1.00 in Montreal; but down 50c. to $3.50 in Minneapolis. Western Pine is off $11.00 in Minneapolis. Seattle base price on form grade plywood is unchanged from last month.

Cement price increased 19c. per bbl. in Minneapolis and 7c. in Montreal. Sand and gravel prices are up 10c. in Boston, but 15c. lower in New York. Paving asphalt increased 70c. per ton in Atlanta. Paving brick is off $4.00 per M in Kansas City, while in Boston, the price rose 50c.

Base price on new billet reinforcing is up 25c. per 100 lb. and is 15c. higher on rail steel reinforcing. Expanded metal lath increased $1.00 and $2.00 in Cleveland. The New York price on 40% ammonia gelatin explosives rose 2c. per pound.

Common brick is up 25c. per M in Kansas City; and lime is up $1.00 in Boston.

Common and skilled labor rates in the 20-cities reported by *ENR* remain unchanged from their July levels

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT — Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL — Per ton, carload lots			CRUSHED STONE — Per ton, carload lots		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.66	$2.61	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.70‡	1.70‡	1.20‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.75	1.75	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.20‡	1.20‡	.90‡	1.20‡	1.20‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.00	1.75	....	1.45*i*	1.45*i*	1.30*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.00	2.75	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.23	1.98	1.78	1.30	1.40	.80	1.30	1.45	1.02‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.50*n*
Los Angeles	2.25*b*	2.05*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	2.90	2.65	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	1.82*r*	1.67*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.25‡*de*	1.25‡*de*	.75‡*de*	1.65‡*de*	1.75‡*de*	....	....	6.75
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.16	1.96	1.66	1.36	1.36	1.36	1.46	1.46	....	....	6.95
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (5c. Tax inTex.)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS — Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	PAVING ASPHALT — Per ton, less than 80 penetration Tank car	Drums	ASPHALT BINDERS — FLUXES — Per gal. 80–300 penetration Tank car	Drums	CUTBACK ASPHALT — Per ton Tank car	Drums	ROAD OILS — Per gal. Tank car	ASPHALT EMULSION (Quick-breaking) — Per gal. Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$17.30*e*	$23.83*e*	$0.0695*e*	$0.1018*e*	$0.0734*he*	$0.1257*h*	$0.0634*e*	$0.0734	$0.1257
Baltimore	140.00‡	44.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.....	.....
Birmingham	.....	27.50*j*‡	.....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.....	.....	.....
Boston	90.00	47.50	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.09‡	.12‡
Chicago	140.00	49.00	1.80*d*	14.50	18.50	13.00*g*	17.00*g*	.06*h*	.095*h*	.04	.09	.125
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.50	2.80	14.50	19.50	.065	.075	.075*h*	.085*h*	.0375	.08	.09
Dallas	.....	30.00	.....	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.15*f*	18.45*f*	.061	.0984	13.15	17.20	.0475	.061	.0923
Kansas City	.....	40.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.135	.185
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	.....	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	135.00	38.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0525	.1125
Seattle	.....	60.00*c*	.....	14.70	22.90	.....	23.50*g*	9.50/10.50	23.00/24.00	7.75*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3½x8½ in.

(Continued on page 78)

THIS IS A NEW "CATERPILLAR" D-7 TRACTOR. AS IN OTHER TRACTORS AND OTHER CONTRACTORS' EQUIPMENT HYATT ROLLER BEARINGS WILL KEEP THEM YOUNG AND FULL OF LIFE.

Yes, Hyatts help your machines stay young . . . help them to make child's play of the toughest jobs! Hyatts insure smooth operation under all conditions at all times. For Hyatts are designed to banish friction . . . avoid wear and care . . . keep related parts in alignment . . . prolong machine life!

To assure far greater use from your contractors' equipment, make sure Hyatt Roller Bearings are a built-in feature. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, N. J., Detroit, Chicago, Pittsburgh and San Francisco.

KEEP THEM YOUNG WITH HYATTS!

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HYATT QUIET ROLLER BEARINGS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton			TRACK SUPPLIES			
						Standard	Light	Re-rolled	Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.15	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	2.15	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.25‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.40*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.75*a*	2.50*a*	....	....	2.95*a*	....	....	....	....	3.00	2.30	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone. Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES	REINFORCING BARS* Per 100 lb., ¼ in., base price				EXPANDED METAL LATH—Per 100 sq.yd., carload lots		WELDED FABRIC REINFORCING—Per 100 s.f., carload lots—			SHEET PILING
	Per 100 lb., base price	15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6 & 6 wires Per sq. yd.	Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.14	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	.....	.10	23.00	25.00	1.70	1.27	.1611	2.80
Birmingham	2.10*a*	2.15	2.05	.02½	.10	20.50	22.50	1.80	1.34	.1701	....
Boston	3.85	2.61	2.46	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	2.15	2.05	.03	.05	19.50	21.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.41*e*	2.41*e*	.....	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58*g*	2.15	2.05	.02½	.10	22.50	23.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	.....	.....	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.35	2.20	.....	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.00	2.51*e*	2.36*e*	.0	.05	18.50	21.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.10	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*e*	2.33*e*	.0	.10	20.00/21.50	23.00/24.50	1.80	1.34	.1701	2.73*d*
Montreal	3.90	2.70	2.60	.....	.....	26.50	29.00	2.99	2.08	.319	....
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	.....	.10	20.50	22.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	2.15	2.05	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.14	2.14	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco	3.35	2.275	2.125	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.75*e*	2.30*e*	.....	.....	.....	25.50	27.50	1.93	1.42	.1827	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5-15 tons, add 15c. 1-5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

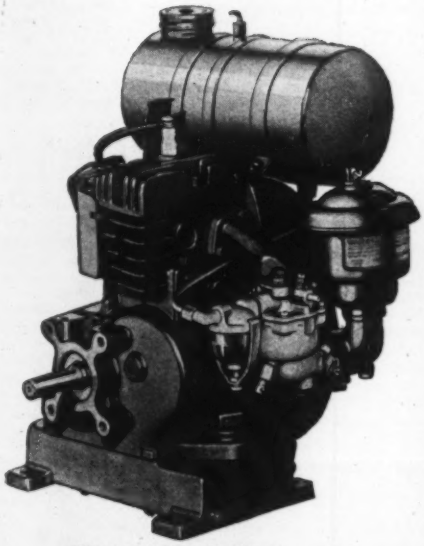
	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE Full standard weight, *h*			
	Per net ton f.o.b. 6 in. to 24 in.*a*	Per foot, std. 8 in., s.s.	delivered std. 12 in., s.s.	ASTM 24 in.,	C13-35 36 in.,	Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	Per ft., delivered: ASTM 12 in.	C 14-35 24 in.	1 to 3 in., Black %	Butt Weld 3½ to 6 in., Galv. %	Lap Weld Black %	Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.642	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.50	1.75	65.5	57.5	63.0	54.5
Birmingham	45.00	.26	.468	1.7875	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.231	.4455	1.89	5.2275	180.00‡	280.00‡	.50	2.30	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.245	.4995	1.9335	5.6375	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland	54.24	.196	.378	1.485	4.51	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.68	5.95*e*	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.....	.....	.....	.....	.....	.....	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.75*j*	1.60*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	.....	.....	.....	.....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ½ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

(Continued on page 80)

of technical knowledge and accumulated experience that is outstanding in the small gasoline motor industry

OUR RESEARCH, DESIGNING AND PRODUCTION ENGINEERS HAVE WORKED TOGETHER FOR YEARS . . . THEY HAVE BEEN RESPONSIBLE FOR MORE THAN A MILLION AIR-COOLED, 4-CYCLE GASOLINE MOTORS.



FULL RANGE OF MODELS
½ to 5 H. P.

STANDARD EQUIPMENT ON

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THESE seasoned experts using the finest materials and the most modern plant and equipment facilities manned by skilled workmen, produce Briggs & Stratton motors that are known the world over for dependable, economical and easy starting, trouble-free performance.

That is why machines and equipment powered by Briggs & Stratton do a better job, day after day, at a lower cost.

BRIGGS & STRATTON CORP.
Milwaukee, Wis., U. S. A.

IT'S POWERED RIGHT WHEN IT'S POWERED BY BRIGGS & STRATTON

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) — All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, R or S	6x12, R or S	12x12, R or S	2x12, R or S	12x12, R or S	5/8"	3/4"
Atlanta	**$20.00**	**$20.00**	**$19.50**	**$19.00**	**$20.00**	**$21.50**	**$26.50**	.....	.....	$38.50	$51.00	$17.75	$21.60
Baltimore	**31.00**	**32.50**	**32.00**	**33.00**	**33.00**	**36.00**	**46.00**	.....	.....	68.00	70.00	17.35*g*	21.15*g*
	33.00	*33.00*	*35.00*	*34.00*	*34.00*	*35.00*	*46.00*	*$46.00*	*$46.00*	.....	.....	.....	.....
Birmingham	**21.50**	**21.50**	**21.50**	**21.00**	**22.00**	**22.50**	**40.00**	**39.00**	**39.00**	.....	.....	16.25	19.85
[1]	23.50	23.50	25.50	23.50	24.00	28.00	55.00	.....	.....	60.00	60.00	.....	.....
Boston	**31.00**[2]	**31.00**[2]	**34.00**[2]	**34.00**	**55.00**[1]	**63.00**[1]	**80.00**[1]	.....	.....	80.00	80.00	17.35*g*	21.15*g*
	30.00	*30.00*	*34.00*	*34.00*	*40.00*	*40.00*	*48.00*	*48.00*	*48.00*	.....	.....	.....	.....
Chicago	**31.00**	**32.00**	**30.00**	**30.00**	**30.00**	**32.00**	**50.00**	.....	.....	80.00	90.00	13.80	16.80
	36.00	*37.00*	*37.00*	*37.00*	*38.00*	*39.00*	*43.00*	*42.00*	*42.00*	.....	.....	.....	.....
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	.....	.....	53.00	56.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*46.00*	*46.00*	*46.00*	.....	.....	.....	.....
Cleveland	**32.00**	**33.00**	**32.00**	**31.50**	**34.00**	**36.00**	**42.00**	43.00	43.00	75.00	75.00	16.70	20.40
Dallas	**28.50**	**32.50**	**31.50**	**29.00**	**30.50**	**32.50**	**52.50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver [‡]	45.00[4]	44.00[4]	43.00[4]	41.00[4]	41.00[4]	46.00[4]	48.00[4]	60.00[4]	71.50[4]	.....	.....	9.90	12.05
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**38.50**	**42.00**	**46.00**	.....	.....	43.00	58.00	16.25	19.85
	.....	.....	.....	.....	.....	*46.00*	*47.00*	*54.00*	*54.00*	.....	.....	.....	.....
Kansas City	**29.00**	**30.00**	**29.00**	**28.00**	**29.00**	**30.00**	**35.00**	.....	.....	55.00	60.00	12.25	14.95
	29.00	*29.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*39.00*	*39.00*	.....	.....	.....	.....
Los Angeles [a]	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis [‡b]	36.00[6]	36.00[6]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
[‡]	*37.50*	*37.50*	*37.00*	*35.50*	*35.50*	*37.50*	*43.00*	*52.00*	*52.00*	.....	.....	.....	.....
Montreal [7]	*35.00*	*36.50*	*33.00*	*35.00*	*36.50*	42.50	45.00	.....	.....	155.00	165.00	.....	.....
	52.00	*54.00*	*52.75*	*55.75*	*57.75*	*60.75*	*54.00*	*54.00*	*54.00*	.....	.....	.....	.....
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	.....	.....	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*36.00*	*36.00*	*34.00*	*36.00*	.....	.....	.....	.....	.....	.....
New York [‡]	**38.00**	**39.00**	**37.00**	**38.00**	**38.00**	**39.00**	**42.00**	.....	.....	80.00*f*	82.50*f*	17.35*g*	21.15*g*
[‡]	.....	.....	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	.....	.....	.....	.....
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	.....	.....	50.00	57.50	17.35*g*	21.15*g*
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis [‡c]	**32.00**	**33.00**	**31.00**	**30.00**	**31.00**	**32.00**	**46.00**	*51.00*	*51.00*	73.00	72.00	13.90	16.95
San Francisco [d]	*22.50*	*23.00*	*23.00*	*22.50*	*22.00*	*22.00*	*23.50*	*23.50*	*23.50*	.....	.....	7.30*g*	8.90*g*
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [6] Norway Pine. [‡] Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $77.00; on 3/4", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower ate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 — Single or Double Thickness — A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%	75%	$0.15
Baltimore	83%	82%	.15
Birmingham	75%	75%	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	79%	79%	.15
Cleveland	79–10–10%	79–10–10%	.205
Dallas	78%	78%	.165
Denver	76–10%	76–10%	.15*e*
Detroit	79–10%	79–10%	.15
Kansas City	77–10%	77–10%	.165
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	76%	76%	.155
Montreal	60–5%*ab*		.17†
New Orleans	70%	75%	.16
New York	81%	82%	.22*f*
Philadelphia	82–10%*d*	83–10%*d*	.15
Pittsburgh	79%	79%	.1425
St. Louis	79–10%	79–10%	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	85%*d*	88%*d*	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and del very regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla	.11 –.12	.135 –.15	.155 –.17
Rocky Mtn. States	.11 –.1325	.13 –.145**	.15 –.165**
Pacific N. W. States	.1075–.115	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6" x 8" x 8' Untr.	6" x 8" x 8' Tr.	7" x 9" x 8'6" Untr.	7" x 9" x 8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.05*a*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*bcf*	....	....	1.95*caf*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.60

(Continued on page 81)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity. Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$26.50	$17.00	$17.00
Baltimore	74.00	80.00	165.00	190.00	235.00	290.00	13.00*k*	16.00*k*	18.50	14.50	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	17.11	11.64	1.56*lo*
Boston	95.05*a*	101.40*a*	190.05*a*	215.35	279.20*a*	319.10*a*	17.00*i*	20.00*i*	21.00	14.00	18.00*l*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	56.50	60.00	112.50	135.00	182.50	209.00	16.00	16.00	15.00*j*	12.00*j*	2.75*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.25	24.00	19.10	12.80	10.70
Los Angeles	73.50*r*	89.50*r*	128.00*c r*	210.00*r*	368.00*r*	460.00*r*	13.50	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*a*	77.50*a*	142.50*a*	76.00*at*	165.80*a*	248.70	20.75	28.00	23.50	17.00	12.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00*c*	193.30*h*	238.80*h*	295.60*h*	13.00	.....	19.00	14.00	17.50
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	15.00*s*	18.00*s*	15.50*q*	9.55*q*	12.05*q*
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

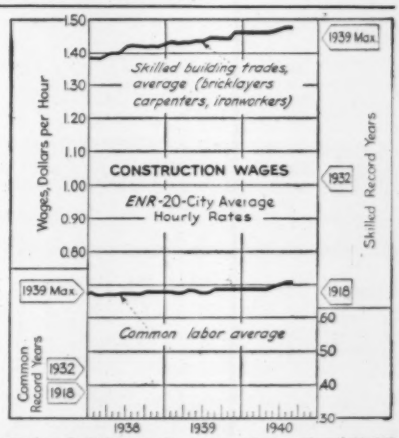
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.75	$13.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	8.50	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	8.75	13.125	2.35	2.75	1.85	1.98	1.57	1.57	.32	27.00
Boston	8.50	12.75	1.80‡	2.40‡	1.75‡	1.75‡	1.85*h*‡	1.85*h*‡	.50‡	20.00‡
Chicago	8.50	12.75	1.96	2.63	1.68	1.48*h*/*f*	1.55*h*/*f*	1.55*h*/*f*	.26/*f*	21.00/*f*
Cincinnati	8.50	12.75	1.65	2.85	1.55	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.50	12.75	1.90	2.60	1.60	1.75	1.50*h*	1.50*h*	.35	21.00
Dallas	8.50	13.50	1.88	2.11	....	2.75*h*	2.60*h*	2.70*h*	.275	34.00
Denver	9.00	13.25	1.65	2.40	.171	2.45	4.00	3.00	.35	18.00
Detroit	8.50	12.75	2.00	3.00	1.75	2.40	2.50	2.50	.35	26.00
Kansas City	8.50	12.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.75	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	8.50	12.875	....	....	....	1.75*i*	1.50*h*/*i*	1.50*h*/*i*	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68*k*
New York	8.50	12.75	1.88	2.55	1.60	1.75	1.50*h*	1.50*h*	.23	24.00
Philadelphia	8.50	12.75	....	....	....	1.92*e*	1.99*h*/*e*	1.99*h*/*e*	.41*e*	21.00
Pittsburgh	8.50	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.50	12.75	1.90/2.00	2.60/2.85	1.60/2.00	1.45	1.45	1.45	.22	21.00
San Francisco	8.75	13.00	1.80	2.75	1.10/2.00	1.65	2.26	2.26	.28	17.00
Seattle	8.75	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00/*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266–31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb. *l* per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.375	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.625	1.375/1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.55	1.375/1.525	1.625	.75	.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.43*b*	1.43*b*	1.43	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.625	1.50	1.55	.60/.75	.60/.775
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.25	1.375	1.375	1.40	.40	.55
New York	2.00*b*	1.85*b*	2.00	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65*b*	1.40	1.65	1.50	1.75	.70	.70
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.50	1.75	1.50/2.00	1.75	.45/.875	.875
San Francisco	1.75*c*	1.25	1.60	1.50	1.60*c*	.813	.813
Seattle	1.60*c*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr wk. *e* 30 hr. wk.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.476
ENR Common Average: $0.707

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MEN AND JOBS

LIEUT. WALTER S. SMITH, U. S. Navy, has been made resident construction engineer in charge of the $3,500,000 emergency air training station at Opa Locka, Fla.

S. R. WRIGHT, professor in the municipal and sanitary engineering department at Texas A. & M. College, will spend the summer months in the city engineering department at Waco, Tex.

J. D. OSBORN, instructor in civil engineering at Texas A. & M. College, will spend the summer with the Texas State Highway Department.

J. T. L. MCNEW, professor of highway engineering in the civil engineering department at Texas A. & M. College, will replace J. J. RICHEY as head of the department of civil engineering, according to an announcement by GIBB GILCHRIST, dean of the School of Engineering. McNew holds an engineering degree from Texas A. & M. and from Iowa State College.

W. O. WASHINGTON, consulting engineer of Brownsville, Tex., has been appointed one of five engineers to judge a highway management competition for county road departments as part of a contest sponsored by *Better Roads*. Other judges are: ROY W. CRUM, director of the Highway Research Board; FRANK W. HERRING, executive director of the American Public Works Association; BEN H. PETTY, professor of highway engineering at Purdue; and HAL G. SOURS, president, American Road Builders' Association.

J. A. ORR, associate professor of civil engineering at Texas A. & M. College, is to be connected with the Texas State Board of Registration for Professional Engineers during the summer months.

JOHN A. FOCHT, professor of highway engineering at the University of Texas, and BANKS MCLAURIN, professor of civil engineering at the University of Texas, are to be employed by the Texas State Highway Department during the summer.

B. F. WILLIAMS, project engineer for the TWA at Fort Worth, Tex., has been appointed by the Texas board of health to investigate possible methods of disposing of salt water in the East Texas oil fields.

COL. CHARLES J. TAYLOR, assistant professor of military science and tactics at the University of Illinois, has been named to succeed LIEUT. COL. W. H. HOLCOMBE, district engineer of the Milwaukee district, U. S. Engineers. Col. Holcombe has been transferred to Ft. Belvoir, Va.

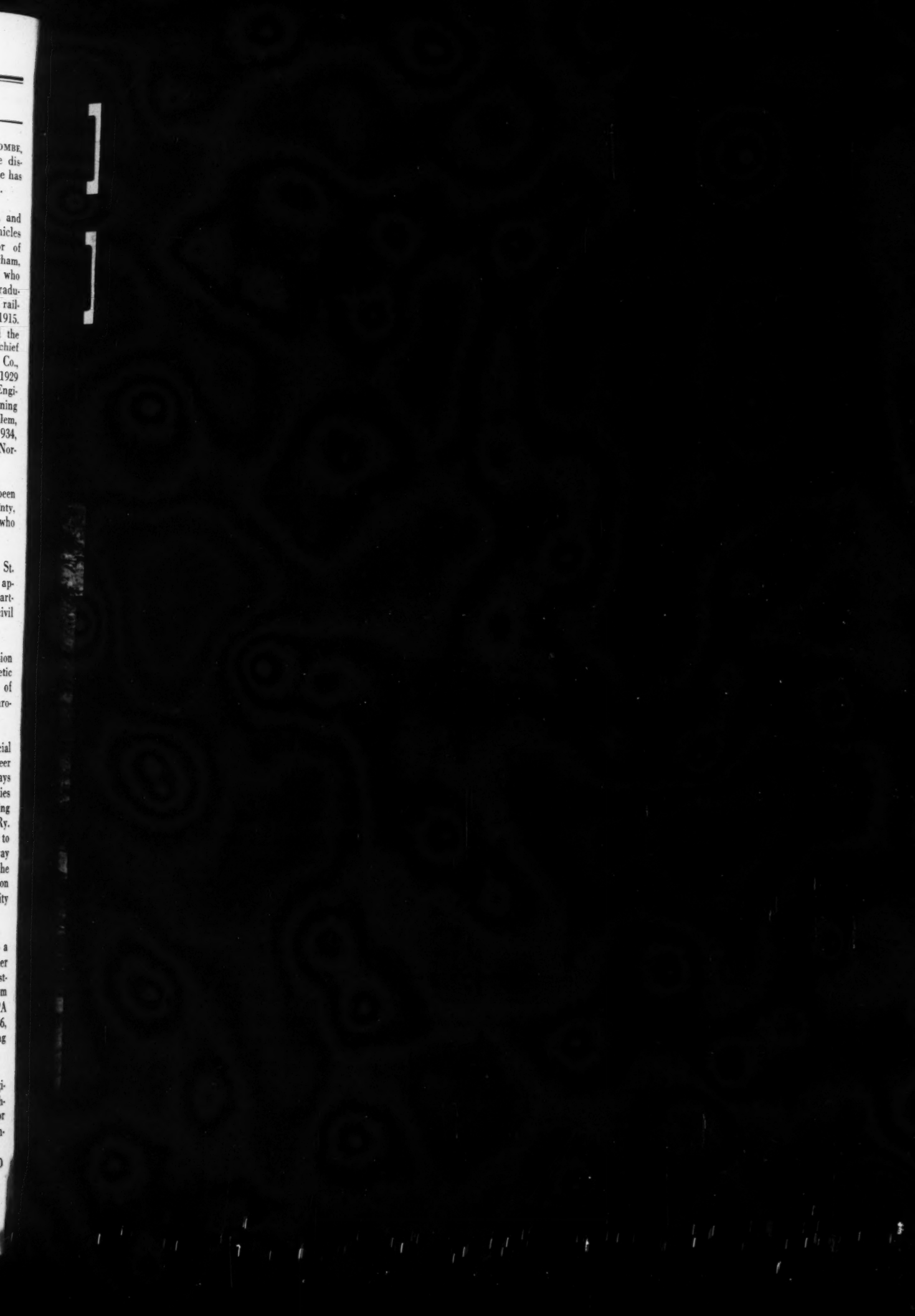
ROY P. BISHOP of Richmond, Va., and director of the Virginia Motor Vehicles Bureau, has been named director of public safety for the city of Durham, N. C., to succeed William J. Croom, who was drowned recently. Bishop, a graduate civil engineer, was engaged in railway construction from 1911 to 1915. Later he served as lieutenant with the 35th Engineers, and as assistant chief engineer for the Cement Products Co., Wilmington, N. C. From 1920 to 1929 he was connected with the Carolina Engineering Co., Charlotte, N. C., resigning in 1929 to become city manager of Salem, Va., a post held until September, 1934, when he became city manager of Norton, Va.

A. I. MEGER, Pipestone, Minn., has been appointed engineer of Pipestone County, Minn., to succeed ELMER KEELER, who has resigned.

JEAN BOUCHARD, city engineer of St. Hyacinthe, Que., has accepted an appointment with the Dominion Department of Transport as engineer of civil aviation for the province of Quebec.

CLEMENT L. GARNER, chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, received an honorary degree of doctor of engineering from North Carolina State College June 3.

J. D. TAYLOR, for the past year special assistant to RALPH BURKE, chief engineer of the Chicago Department of Subways and Superhighways, has begun new duties as engineering assistant to the operating vice-president of the Great Northern Ry. with headquarters at St. Paul. Prior to his connection with the Chicago subway project, Taylor was employed in the bridge department of the Burlington R.R. He is a graduate of the University of Illinois.

KARL C. KASTBERG has been hired as a special field assistant to City Engineer JOHN TIPPEE of Des Moines, Iowa. Kastberg, city engineer of Des Moines from 1916 to 1928 and superintendent of WPA operations in that city from 1934 to 1936, will do special work on engineering surveys.

B. S. MARSH, a member of the engineering staff of the North Carolina Highway and Public Works Commission for a number of years, has left that organ-